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ABSTRACT

A course intended to upgrade essential reading and mathematics skills in students who show poor performance or negative attitudes towards school has been developed at A. Lincoln High School in San Jose, California. Called Project R-3, it seeks to motivate students by emphasizing student readiness, subject relevance, and learning reinforcement through a varied program of individualized instruction, field trips, and gaming and simulation devices. The program for 1970-1972 taught grades eight and nine. Average gain in basic skills was nine months for reading and one year for mathematics, over seven months of instruction. The contents of this report include a complete program description and guide to replication, a discussion of the theory of gaming and simulation, and sixteen games and simulations to be used in reading and mathematics instruction. (RB)

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PROJECT R-3

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A motivational program emphasizing student Readiness, subject Relevance, and learning Reinforcement through individualized instruction, intensive involvement, and gaming/simulation.

CALIFORNIA STATE DEPARTMENT OF EDUCATION
DIVISION OF COMPENSATORY EDUCATION

San Jose Unified School District
Technicon Education Systems
Rand Corporation

Contents

- PROGRAM DESCRIPTION AND REPLICATION GUIDE
- THEORY OF GAMING AND SIMULATION
- REPRODUCIBLE GAMES AND SIMULATIONS

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HOW THIS BOOK IS ORGANIZED

Unlike most books, which are read and set aside, this book is meant to be used. Each of the three sections is intended to stimulate a particular kind of action on the part of the reader. For the educator searching for solutions to undermotivation and underachievement in math and reading, the section titled "Program Description and Replication Guide" offers information on how these problems were successfully attacked in Project R-3. The educator is invited to investigate Project R-3's methods and consider applying them to serve his or her needs. Project R-3 is located at the Abraham Lincoln High School in San Jose, California. Interested individuals and groups are invited to come and see Project R-3 in action and talk with the Project staff on any matters discussed in the "Program Description and Replication Guide."

For curriculum and media specialists, as well as interested teachers, there is a section titled "Theory of Gaming and Simulation." This section summarizes briefly the research which led the originators of Project R-3 to incorporate Gaming/Simulation as a major component. While it cannot be said categorically that educational games and simulations are the most effective learning media, they are being used increasingly in the classroom. Also, educational games and simulations are increasingly becoming the subject of educational publications, conferences, and symposia. The Project R-3 staff believes that the educational and motivational games used in their classrooms have been principal contributory factors in effecting attitudinal change and improving math and reading skills. We strongly encourage the reader to investigate the subject further and to consider incorporating this educational medium into the curriculum.

For the classroom teacher, the section titled "Reproducible Games and Simulations" offers an assortment of R-3 games and simulations that are "in the public domain" and may be used to serve individual needs. The games are meant to be studied by the teacher, taken out of the book, reproduced, and used in the classroom. A brief preface to that section relates the games and simulations to skills, etc.

In sum, this book is meant to be not only a catalyst for action but also the action itself. For those who have never employed Gaming/Simulation in the classroom, or have used it in only a limited way, we urge you to experiment with the R-3 games and simulations. We believe you will discover that this medium offers an effective and exciting way to liberate the creative potential that is in all students.

PROGRAM DESCRIPTION AND REPLICATION GUIDE

A motivational program emphasizing student Readiness, subject Relevance, and learning Reinforcement through individualized instruction, intensive involvement and gaming/simulation.

PROGRAM DESCRIPTION

Objectives of Project R-3

Project R-3 is based on the philosophy that if a student has the mathematics and reading skills necessary to function at grade level, then not only can he succeed in other areas of education but also he can succeed in the world of work. Based on this philosophy, Project R-3 has as its objective improving both reading and mathematics skills.

The other objectives of Project R-3 are to change the self-image of students from one of failure to one of success, and to change their behavior patterns as students by providing them with immediate success experiences.

The 1970-71 program included all eighth grade students, and the 1971-72 program continues the program for these students in the ninth grade. A majority of the students exhibit some, or all, of the following characteristics:

- Poor performance on standardized tests
- Classroom performance significantly below grade level
- Low level in verbal functioning
- Negative attitude toward school and education
- Low occupational and educational aspiration level
- Expectations of school failure
- High absentee rate

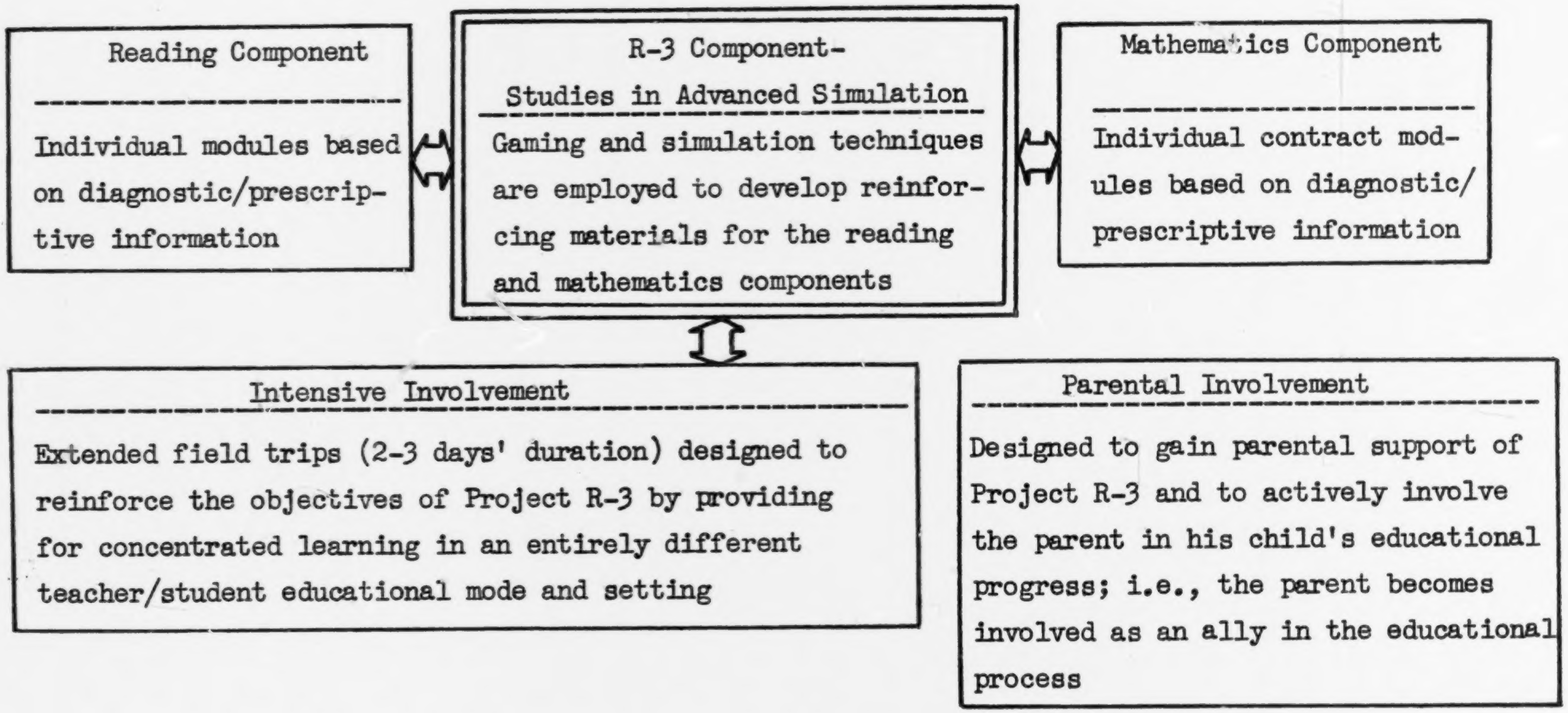
The Nature of Project R-3

The major components of the ninth grade program are reading, mathematics, R-3 (studies in advanced simulation) and intensive involvements. Project R-3 was designed jointly by the San Jose Unified School District and the Education Systems organization of Lockheed Missiles & Space Company (now Technicon Education Systems) with the help of consultants from San Jose State College. Project R-3 includes a curriculum that interrelates reading and mathematics with reinforcement through gaming/simulation, intensive involvements (a series of extended field trips), parental involvement and an inservice training program for staff development.

The interrelationship of the components is shown in the figure on the following page. The central placement of the R-3 Component-Studies in Advanced Simulation is intended to illustrate its pivotal role in the design and operation of Project R-3. The essential features are briefly described for each component. Replication of Project R-3 requires all components. It is possible, however, that individual components or materials developed for the program can be used in other instructional programs.

There is no evidence that partial use of project materials will achieve the same results. The reinforcing nature of the R-3 component would strongly indicate that it could be successfully combined with other reading and mathematics courses. In addition, many of the gaming/simulations can be used in any classroom to teach or reinforce specific concepts or skills. Each gaming/simulation activity or exercise states its behavioral objectives.

The main objective of Project R-3 is the upgrading of essential reading and mathematics skills. By deeply involving the students in classroom games and simulations, the program seeks to motivate them to achieve in learning experiences--to make them ready to learn, to make learning relevant, and to reinforce positive attitudes and behavior.



Reading Component

Individual modules based on diagnostic/prescriptive information

R-3 Component-

Studies in Advanced Simulation

Gaming and simulation techniques are employed to develop reinforcing materials for the reading and mathematics components

Mathematics Component

Individual contract modules based on diagnostic/prescriptive information

Intensive Involvement

Extended field trips (2-3 days' duration) designed to reinforce the objectives of Project R-3 by providing for concentrated learning in an entirely different teacher/student educational mode and setting

Parental Involvement

Designed to gain parental support of Project R-3 and to actively involve the parent in his child's educational progress; i.e., the parent becomes involved as an ally in the educational process

Components of Project R-3

Program students are grouped into heterogeneous classes, using an objective technique developed by The Rand Corporation. Each class reflects the achievement range of the entire program population and has an equal distribution of boys and girls. As a result, those students with social or behavior problems are distributed among all the classes. In addition, heterogeneous grouping provides successful peer models for the underachievers

Resources Needed

With the exception of the materials developed for the R-3 component, the intensive involvements and some of the mathematics contracts, the project makes use of commercially available materials. A wide variety of audiovisual equipment is used--overhead, film, and slide projector; tape recorders; language masters; listening post; microphones; videotape cameras, monitors, and recording consoles; calculators and typewriters. The audiovisual materials include videotapes of lessons and trips, tape-recorded materials such as guest lectures, slides and films.

The materials and equipment used in Project R-3 are of secondary importance to the motivational components. Any available standard, published materials, especially those emphasizing individualized instruction, can be adapted to teach subject matter strands of reading and mathematics.

Minimal remodeling of classroom space was done to improve the environment and to add the necessary electrical outlets. Flexible conference-type tables and stacking chairs replaced conventional furnishings.

Personnel

Personnel for the program include the director, the assistant director and the instructional staff. The instructional staff of Project R-3 consists of regular district teachers who were given a short period of pre-service training and continuous in-service training. A desirable, but not necessary, criterion for selecting instructional aides from the community was an ability to speak Spanish.

Although Project R-3 operates with a teacher and an instructional aide assigned to a classroom of twenty students, there is no evidence to support this ratio as a prerequisite. In fact, most of the project staff have indicated that a higher student-adult ratio would be feasible.

Operational Procedures

Each program student participates in a three-period core of reading, mathematics, and R-3 (studies in advanced simulation). Social studies, physical education, and one elective subject comprise the remainder of the students' program and are taken with the other ninth grade students.

In both reading and mathematics classes, emphasis is placed on individualized instruction to meet the special needs of each student. Program personnel estimate that 70 percent of the classwork is done in an individualized learning situation and the other 30 percent in small groups of from two to seven students.

The reading component of Project R-3 utilizes a diagnostic/prescriptive approach in a reading laboratory situation. The mathematics component uses a diagnostic/prescriptive approach as well as discovery techniques and multisensory inputs. Each student is on an individual progress program in both reading and mathematics. Relevance to the students' world is stressed. The R-3 component uses a series of motivational materials including gaming/simulations and intensive involvements--extended field trips of two or three days' duration. As mentioned earlier, the R-3 component is the focus of the program, utilizing and reinforcing the skills and concepts learned in the reading and mathematics components.

An intensive involvement is a series of learning experiences built around a particular theme, and including one or more gaming/simulation activities. These two or three day intensive involvements require that students and project staff travel to a locale suitable to the activities. The highly structured student-teacher relationship is supplanted by a much freer atmosphere. Learning experiences conducted outdoors and away from class schedules and period bells help to promote this different educational environment. After the return from an intensive involvement, classroom activities build on the experiences of the students.

The parental involvement of Project R-3 focuses on drawing parents and students together. Every effort is made to involve parents in all phases of the project, and regular home visitation by project staff is an important component. Parents are invited to visit classrooms and observe and participate in learning activities; Spanish-speaking personnel are available to assist them at the school. Parents are encouraged to go on study trips and to the intensive involvement sites. Dinner meetings for parents, students, and program personnel are held periodically in the school cafeteria to review progress to date and plans for the future. Parents who are unable to attend are sent a newsletter about the meeting, one copy in English and one in Spanish.

Project R-3 in-service training is conducted during the first period of the school day. The staff utilizes this time for three periods a week for group meetings to coordinate activities, discuss common problems, share ideas, and plan ways to tie the major components of Project R-3 together. In addition, the R-3 program teachers who teach the same subject also meet for the other two periods a week to plan special activities for their classes. Other meetings and workshops are held as needed. For example, because work on R-3 curriculum was needed, a workshop was held for three weeks during the summer. Six of the program teachers and an industry research specialist participated in developing the curriculum for the program.

Evaluation

Project R-3 contracts for an independent evaluation with the Rand Corporation of Santa Monica. The evaluation design provides for an assessment of progress toward the goals of the project, both in the areas of achievement and attitude. A major part of the effort focuses on evaluation for program improvement. Suggestions for program improvement were made to the project director. There is evidence that the project has benefited greatly from the contributions of disinterested observers.

Rand also designed a cost model that allowed the project director to assess the impact of changes in the program configuration when planning future programs or modifying the current program. A method for allocating costs to each component was set up and implemented. This assured that instructional and non-instructional costs could be separately identified.

Average gain on the California Test of Basic Skills, Form R, Level 3 for project students in the eighth grade was nine months in reading and one year in mathematics. This gain was achieved during seven months of instruction, and represents a substantial improvement over expected gains of four to five months that are generally achieved in a deprived population for a comparable instructional period.

REPLICATION

CONSIDERATIONS IN REPLICATING PROJECT R-3

Many teachers, curriculum coordinators and building administrators are reluctant to replicate promising programs because of difficulties encountered in planning and implementing the program. A specific focus throughout Project R-3 has been on the planning procedures necessary for partial or total replication of the program. As a result of this focus, several problem areas that might be potential obstacles to replication have been identified. The best approach to replication is, we believe, a dialogue with the current staff as a means to explore ways of coping with these obstacles. Since this might not be possible, or practicable, the next best approach is to discuss those areas that have been identified as warranting consideration. Explicit solutions are not provided because each district has its own unique problems and its own program planning practices. Our purpose here is to enumerate the considerations that should facilitate the tailoring of Project R-3 to the uniqueness of other districts. These considerations fall into five broad groups:

- Preliminary Planning
- Availability of Resources
- Program Development
- Operational Procedures
- Evaluation Procedures

Preliminary Planning

- Is there a need for this program in my school (district)? The whole program? A part? (if only part, which part) What instruments should be used to determine the student needs?
- Would a program now under consideration fit into my school's (district's) organization and would the local school board approve it?
- Would the parents of the attendance area support and help plan a program?
- Could the curriculum of the program be developed by the personnel who would staff the program, or would it be necessary to work through district curriculum coordinators at the district level?

- How would your district staff a program?

- Would the school staff (teachers and administrators) receive a program and work as a team?

- What would be the administrators' roles with respect to the program?

- Who would have direct administrative control of the program?

Availability of Resources

Project R-3 can be replicated within reasonable financial constraints. There are, however, other resources that are essential to the implementation of the program. Most schools, or districts, have the needed resources briefly listed:

- Rooms, fixtures and furniture that allow for a student-centered, activity-oriented instructional mode.

- Teachers of average ability and experience who can conduct classes in reading and/or math and related motivational activities.

- Instructional support services such as audio-visual center, remedial library center, professional library, depository of textbooks, and the services of curriculum coordinators.

Program Development

The following considerations were relevant to the development of Project R-3:

- Set realistic goals and keep them highly visible.

- Specify measurable behavioral objectives for each goal.

- Choose tests whose content reflects program instructional objectives.

- Choose tests suitable to item analysis so that individual study may be prescribed.

- Develop and maintain an individual progress record card for each component.

- Carefully consider personalities in matching teachers and aides.

- Provide a balance between affective and cognitive learning.

- Do everything possible to maintain the heterogenous grouping of students.

- Recognize that there is no "scope and sequence" in the math and reading components. Individualized instruction determines the scope and sequence for each student.
- Stress inductive learning
- Provide for both the most able and the least able student.
- Develop a variety of learning experiences.

Operational Procedures

Good operational procedures, both long-range and day-to-day, play a vital role in achieving a successful program. Some of the procedures that have contributed to the smooth operation of Project R-3 and that merit consideration when replicating Project R-3 follow:

- In-service training sessions for the program staff are conducted on a reasonable, but structured, schedule.
- All aspects of the program share in the in-service component.
- Lines of responsibility are defined and maintained.
- The program staff makes a conscious effort to remain an integral part of the total school staff.
- The program's schedule is an integral part of the school's master schedule.
- Program-unique problems are solved jointly with other school problems.
- Staff duties are clearly defined, written and communicated.
- One person has overall fiscal responsibility even if each component has internal budgetary control.
- Within the constraints and supervision necessary to insure that the spirit of the program is maintained, teachers are allowed as much classroom freedom as possible.
- Students in the program are counseled by regular school counselors along with all other students.

- Minimum standards of student behavior are the same for program students as for all other students.
- Individual progress cards are always available for parent conferences.

Evaluation Procedures

Evaluation procedures obviously cut across the considerations discussed in preliminary planning, program development and operational procedures. We are discussing evaluative considerations separately because they are equally important in both development and replication of a program. The following list is by no means exhaustive, but highlights Project R-3 experience.

- Evaluation design is closely integrated with all other pre-planning activities.
- Project goals are translated into measurable objectives.
- Criteria for program success are clearly established.
- Purposes to be served by the evaluation are stated, i.e., for measuring student achievement, for measuring other program objectives, and for improving the program.
- Procedures for collecting the necessary data are developed.
- Evaluation is an on-going two-way continuous process among the evaluator, the program administration and the program staff.
- The results of evaluation are presented in such a way as to support cost-effectiveness analysis.

SELECTED LIST OF PUBLICATIONS PERTAINING TO PROJECT R-3

1. Annotated Bibliography of R-3 Materials for Dissemination, San Jose Unified School District, San Jose, California, Mimeographed paper.
2. Gaming/Simulation Workshop, Project R-3, Lockheed Missiles & Space Company, Sunnyvale, California, 1970.
3. Hull, Leonard, Description of Project R-3 A.B. 938 Demonstration, San Jose Unified School District, San Jose, California.
4. Project R-3, 7th Grade Intensive Involvement Mother Lode Trip 1970 Teacher's Guide, Lockheed Missiles & Space Company, Sunnyvale, California.

5. Project R-3, 7th Grade Motivational Program, Perceiving Our World, San Jose Unified School District, San Jose California, Mimeographed paper.

6. Sumner, G. C., Project R-3 Allocation of Students Among Groups, The Rand Corporation, P-4584, February, 1971.

7. Rapp, M. L., et. al., Project R-3, San Jose, California: Evaluation of Results and Development of a Cost Model, The Rand Corporation, R-672-SJS, March, 1971.

8. Rapp, M. L. and G. C. Sumner, Evaluation of Project R-3, San Jose California, 1970-71, The Rand Corporation, WN-7507-SJS, July 1971.

ADDITIONAL INFORMATION ABOUT PROJECT R-3

The district has audiovisual documentation of the R-3 program. A slide and tape presentation is available, as are several publications prepared by the project staff. Arrangements to see the presentations or obtain the publications can be made by contacting Mr. Leonard Hull.

A booklet called It Works (OE-37040) describes Project R-3 as it existed during its first three years of operation. It is available for 25 cents from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

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THEORY OF GAMING AND SIMULATION

TECHNICON EDUCATION SYSTEMS BACKGROUND IN GAMING/SIMULATION

Technicon Education Systems has developed a capability for design of innovative and effective educational programs in cooperation with school districts interested in educational research and exemplary programs funded by federal, state, and local agencies. They do not perform studies; but, for school utilization, they do produce materials and procedures that transcend the availability of specialized personnel and operate effectively with normal school staff. Their programs and products include the development of 7th, 8th, and 9th grade curriculum materials based on gaming/simulation and instructional technology which are designed to stimulate learning interest and improve the reading and mathematics skills of junior high school students.

The Technicon Education Systems group is not composed of educators. It is a group of educational program designers who apply proven components to synthesize systems that are effective and reliable in their ability to meet the specific learning needs of students. The Education Systems group has specialists in instructional technology, science, and media. In addition the group can draw on the knowledge of approximately 2,000 professional personnel of the parent corporation, which is based on high technology.

While gaming and simulation have been combined in the work at Johns Hopkins and at Northwestern University, the sites of most intensive political science instruction by gaming/simulation, the elements of instructional technology have remained separate from instruction based upon games and simulations. Gaming/simulation (G/S) incorporated with instructional technology is a different method that has evolved from intensive work performed by Technicon Education Systems in the public school setting.

The combination of G/S with instructional technology techniques has been in operation in classrooms of the San Jose Unified School District, with measurably significant effects, for five years. Here, the subjects have been seventh, eighth, and ninth grade underachieving students. Significant results were obtained in another G/S and instructional technology-based program, the San Francisco Unified School District's $(EDP)^2$ Program.

THEORETICAL BASIS FOR EMPLOYING GAMING/SIMULATION IN THE CLASSROOM

William C. Morse believes that most delinquent children have developed a strong defense against accepting the broader code of society. He also feels that these children are quick to learn what they deem useful to them while rejecting the routine and drill aspects of schoolwork (William M. Cruickshank and G. Orville Johnson, eds., Education of Exceptional Children and Youth, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1958). The Technicon Education Systems approach is specifically designed to provide the explicit relevance and motivational aspects to learning and to instill the broader code of society by involving the student in simulated real-life activities. (See the group of papers in H.S. Guetzkow, ed., Simulation in the Social Sciences, Prentice-Hall, New York, 1962, demonstrates this consistently. Also see the set of documents in the American Behavioral Scientist, 10, No. 2, October & November 1966).

The rationale for utilizing G/S as an instructional methodology for underachievers derives much of its justification from the success of G/S as it has been applied to different types of learning situations and learner needs in several programs over the past ten years. G/S was developed originally in the educational frame of reference for adult learning experiences. "War games" have been used in the United States for at least sixty years. Management simulations have developed nearly concurrently with another variety of adult gaming, political games, and both have built upon the same basic structure. This structure is generally understood to contrast with conventional instruction in the following ways:

GAMING/SIMULATION	CONVENTIONAL
A conflict situation is represented to involve the learner actively.	Learner function in an observer's or audience role.
Learner must assume a role.	No opportunity for role-playing.
Learner is made to realize his own control over events that make up the game situation.	Except for laboratory work, the learner has no effect upon events represented by textual materials.
Game controls learner's range of meaningful responses through structured reference to set of rules.	Learner may frequently have free associations following exposure to unstructured texts and other stimuli.
Team learning is emphasized.	Individual or solitary learning.
Cognitive and psychomotor tasks exist in combination.	No psychomotor activities in most classroom situations.
Short-term goals and immediate feedback is frequently part of the G/S.	Most frequently, delayed goals and protracted feedback.

The advantages for G/S in general that have been postulated and, with varying degrees of certainty, proven over the past five years are the following. Games and simulations are more effective than conventional methods of instruction in gaining the interest of learners, and in motivating the learners to become more involved with learning activities. (Simulation Games in Learning, Edited by Sarane S. Boocock and E. O. Schild, with a Preface by James S. Coleman, "Individual and Group Effects on Enjoyment and Learning in a Game Simulating a Community Disaster" by Michael Inbar, Beverly Hills, Calif., Sage Publications, Inc., 1968, pp. 169ff)

Games and simulations afford a manageable way for skills practice; sensory inputs may be modified through various modes of stimulus equivalence so that certain skills are given more intensive treatment than the total matrix of skills - some of which may need little attention through practice. (Robert M. Gagne, "Simulators," in Robert Glaser, ed., Training Research and Education, John Wiley and Sons, New York, 1965, pp. 235ff).

Games sustain a higher than ordinary interest in subject matter as measured by a number of instruments. (Clee H. Cherryholmes, "Some Current Research on Effectiveness of Educational Simulations: Implications for Alternative Strategies," American Behavioral Scientist, 10, No. 2, October 1966, p.5)

The work on adult education by simulation in the "Jefferson Township School District" (reported by John K. Hemphill, Daniel Griffith, and Frederiksen, Administrative Performance and Personality, Bureau of Publications, Teachers College, Columbia University, New York 1962) demonstrated that G/S offered a unique process for combining effective and cognitive skills development. "Theory and practice come together more effectively than in conventional classroom situations" (Richard Wynn, "Simulation: Terrible Reality in the Preparation of School Administrators," in Richard A. Kaimann and Robert W. Marker, eds., Educational Data Processing: New Dimensions and Prospects, Houghton Mifflin, Boston, 1967, p. 297).

Decision-making appears to be truly fitted to the G/S method of instruction (Gagne, Simulators, p. 243; Guetzkow, Simulation; James S. Coleman and F. Waldorf, "Study of a Voting System with Computer Techniques," Johns Hopkins University, Baltimore, 1963). And decision-making is at the core of most meaningful learning.

Whether or not critical thinking habits, attitudes, and specific bodies of factual data are best handled in a simple game/simulation is subject to a divergence of opinion and results that range from negative, through no significant difference (when comparison is made with conventional instructional techniques), to positive. The literature offers a broad choice for the reader.

There is a set of G/S features that have demonstrable effectiveness in various areas of instruction and bearing directly on the needs of the underachieving learner. From the brief list above, most important is the apparent effectiveness of games and simulations to link affective and cognitive skills development for the learner. Only by equivalent growth of knowledge and perception does this type of learner become well-suited to the particular set of tasks in his learning environment.

The modification of sensory input to the learner is a crucial feature of G/S that Project R-3 has endeavored to exploit fully. Such modification is, in reality, data compression. The learner can well be overcome by the welter of incoming visual and auditory stimuli of the real world or even the filmic presentation of that world. Data compression, through the structuring and arrangement of stimuli to the students in the program, offers an effective means for controlling the level of intensity of the first impressions that strike the student.

Other essential features of G/S that have particular significance include:

a. Efficacy. An noted by most analysts of G/S, gaming provides an opportunity for the learner to experience a sense of his own control in dealing with inputs. As he performs tasks and manipulates the inputs, he observes directly the results of his individual contribution. Boocock, Experimental Study, p. 16, notes this; and Jerome Bruner, Toward a Theory of Instruction, Belknap Press, Cambridge, Massachusetts, 1966, p. 135, identifies the function of rules and structure in a game to be one of limiting "anticipated consequences of activity," of programming the learner so that he has a feeling more redolent of control than of impulse and randomness.

b. Removal or Mediation. Symbolic representation of real world, isolated activity, limited impact, and indirect involvement provide an insolation from the consequences that would result from the real activity that is simulated. Students can practice, can explore and, as a result, can learn more fully. Bruner puts this in terms of the play component of the instructional game/simulation: "Play serves the function of reducing the pressures of impulse and incentive and making it possible thereby for intrinsic learning to being." (Wynn, Simulation, Terrible Reality, p. 297, states that "simulation permits the learner to profit from mistakes that might be disasterous on the job.")

c. Introspection. Because the learner is removed from the real world, he is permitted an inward analysis of his own motives and attitudes and an examination of his internal decision process. He is afforded the opportunity to develop an inner dialogue and to build insight to the point of introspection. "Simulation permits a degree of introspection rarely provided on the real job" (Wynn, p. 298).

d. Empathy. This feature of learning by G/S has been pointed out, but never accurately quantified, by nearly every student and designer of games. (See Robinson, Simulation. p. 112.) This facet of G/S affords the pupil an understanding of the effect of environment on others, the external impact of decision-making, and insight into others' problem-solving processes.

e. Colleagueship. The term comes from E. Gross, "A Functional Approach to Leisure Analysis," Social Problems, 9, No. 1, Summer 1961, p. 5. Gaming and simulation, by introducing restricted elements of the outside world into the learning situation where people are working and learning together, facilitates team learning and team identification. If all the elements of the real world are incorporated, tensions arise and the team role disintegrates. (See Robert F. Bales, "Adaptive and Integrative Changes as Sources of Strain in Social Systems," in A. Paul Hare, Edgar F. Borgatta, and Robert F. Bales, eds., Small Groups, Knopf, New York 1955, pp. 127 - 131.)

f. Time Compression. Closely related to e. above is this element of G/S; Robert E. Ohm, "General Instructional Simulation: An Exploratory Model," p. 306, states that, on the basis of research and development in the field, "gaming the group process provides a short cut to the establishment of certain essential group process elements." (Kaimann and Marker, Educational Data Processing.)

Games and simulations offer an excellent means for introducing concepts and developing fundamental skills in underachieving students. Most likely, the component of play in games/simulations for young learners allows tension reduction and the limitation of the consequences of gaming activity; this, according to Bruner, is essential for uninhibited and pleasurable learning to transpire. Play has also been identified as a great motivator for teaming or, in Bruner's terms, for reciprocity which "involves a deep human need to respond to others and to operate jointly with them towards an objective." (p. 94) Huizinga states that,

> Closely connected with play is the idea of winning. Winning, however, presupposes a partner or opponent; solitary play knows no winning, and the attainment of the desired objective here cannot be called by that name. What is 'winning,' and what is 'won?' Winning means showing oneself superior in the outcome of a game. Nevertheless, the evidence of this superiority tends to confer upon the winner a semblance of superiority in general. In this respect he wins something more than the game as such. He has won esteem, obtained honor; and this honor and esteem at once accrue to the benefit of the group to which the victor belongs. Here we have another very important characteristic of play: success won readily passes from the individual to the group. (Johan Huizinga, Homo Ludens: A Study of the Play Elements in Culture, Beacon Press, Boston 1955.)

The final element to be described here is that of the structuring of the data input to the learner. Structure could as readily be the single term to describe the outstanding feature of G/S as any other, for virtually every aspect of a game or simulation has demonstrable characteristics that are recognizable for their effect only within a matrix linking all of the other G/S characteristics. So it is that one may discuss the elements of a game, or what it is that constitutes the game, only be referring to the attributes of the game (the descriptors of the elements). But neither of these can be analyzed without reference in some detail to the game activities which in turn, are given meaning and regulation by game plans (the policy and doctrine that, nor surprisingly, refer back to the game elements).

Structure may be viewed in terms of time or in terms, more or less pure, of space. To link time and space in reference to the learning individual and his perception of incoming data is, as the last few hundred years attest, no simple matter. (See, for a recent critique, Edwin G. Boring, History, Psychology, and Science: Selected Papers, John Wiley, New York 1963; in particular "Psychophysiological Systems and Isomorphic Relations," pp. 287-303.)

Jerome Bruner makes the case for structure as it facilitates the transfer of not only specific skills but general principles and concepts from one situation to the next. (The Process of Education, Vintage Books, New York, 1963, pp. 17 - 32.)

Whatever the underlying psychophysical or psychogenic realities, a most frequently indicated benefit of the gaming/simulation mode of instruction has been the dynamic-purposive structure imposed on all aspects of the learning situation. This includes data presentation, problem formulation, operations, reward system, payoff or results of learning activities. Project R-3 consistently utilizes structure throughout the G/S application, employing some of the basic techniques of instructional technology; e.g., behavioral objectives are added to the game strategy in order to ensure instructional efficacy.

REPRODUCIBLE GAMES AND SIMULATIONS

INTRODUCTION

The format of the following R-3 games and simulations is intended to simplify their use in the classroom. Each game or simulation begins with a page that summarizes it, states its learning objective(s) ("SOLO" = statement of learning objective) and itemizes the ancillary materials required, if any. A Teacher's Guide, with information on points to be stressed, room set-up, etc. follows. Each packet of material also contains the student's materials.

REPRESENTATIVE R-3 GAMES AND SIMULATIONS

The games and simulations in this book are drawn from the R-3 7th, 8th, and 9th grades. The diversity of subjects and titles is explained by the fact that each grade level has a particular theme (7th: Perceiving Our World, 8th: World of Work, 9th: Governing Our World). In each grade level there are "Units" consisting of one-, two-, or three-week "clusters," or subthemes. The following selection demonstrates the divergent approaches and uses of gaming and simulation as used in Project R-3:

SELECTION MATRIX

R-3 Game/Simulation	Exercised Skill(s)	Primary Content Area	Secondary Content Area
Survival in Space	Math.	Math	Sci.
Hip Town Junk Problem	Math., Rdg.	Soc. St.	Math.
Moving Day for the Lemmings	Follow Oral Instr.	Math.	
Race to the Hospital	Follow Oral Instr.	Sci. ("ESP")	Math.
Classroom Teaching Contest	Verbaliz., Math., Rdg.	Soc. St.	
Submarine Escape and Rescue	Lang. Arts, Math.	Sci.	Math.
I. Yankem, D.D.S.	Rdg.	Sci.	
Loan Officer's Simulation	Rdg., Math.	Soc. St.	Math.
Transportation Commission Study	Rdg., Math.	Soc. St.	Math.
Business Telephone Call	Rdg., verbaliz.	Soc. St.	
Light Bulb Inspector's Simulation	Follow Oral Instr.	Sci.	
Railroads: Passenger Service	Rdg.	Soc. St.	
Sewage Treatment Plant Study	Rdg.	Sci.	Soc. St.
The Ringelmann Chart	Rdg., Math.	Sci.	Soc. St.
Car Count and Pollution Forecast	Rdg., Math.	Sci.	Soc. St.
Hurricane Warning Game	Rdg., Math.	Sci.	Soc. St.

HOW TO USE R-3 GAMES AND SIMULATIONS IN YOUR CLASSROOM

Read the Summary Page and Teacher's Guide a few days before you conduct the activity. Refer to the Materials List and obtain the required items. Remove and reproduce the pages or Student Materials. When you conduct the activity, be prepared for encores !

Activity 2

SURVIVAL IN SPACE

SUMMARY

Students pair up, each with his own gamesheet. In turn, each throws a die three times, reads numerical quantities from three horizontal bar graphs, and copies the quantities onto an appropriate "track" leading to a satellite. Periodically, both students tally the quantities they have recorded thus far to "see how well they are doing." The object of the exercise is to see which player can deliver the larger quantity of necessities to the spaceship.

SOLO'S

1. The student can read numerical quantities from a horizontal bar graph.
2. The student can copy numerical values onto appropriate areas.
3. The student can add columns of one- and two-digit numbers.

MATERIALS

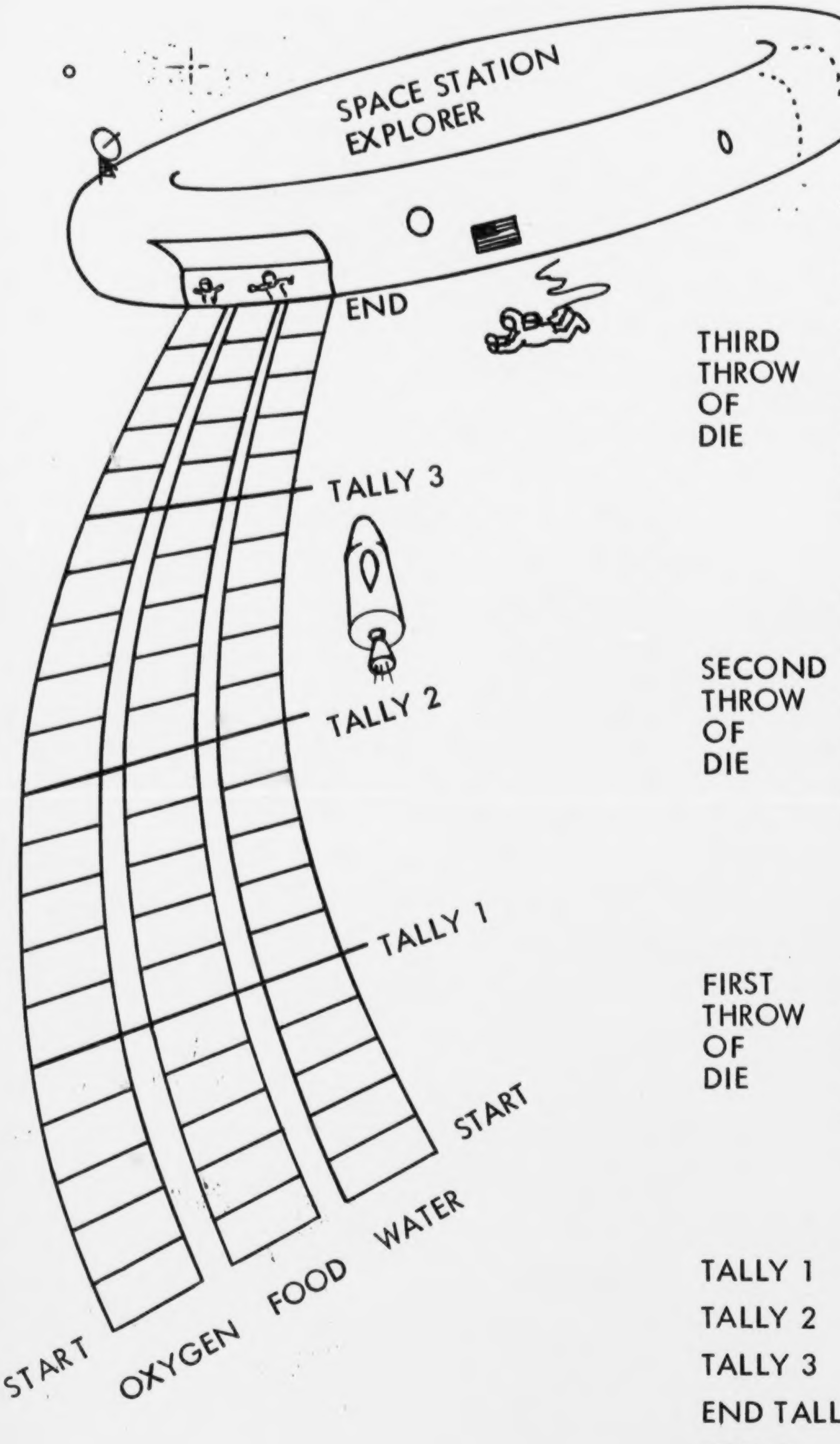
- Two "Survival in Space" gamesheets for each student
- One die for each pair of students
- Pencils

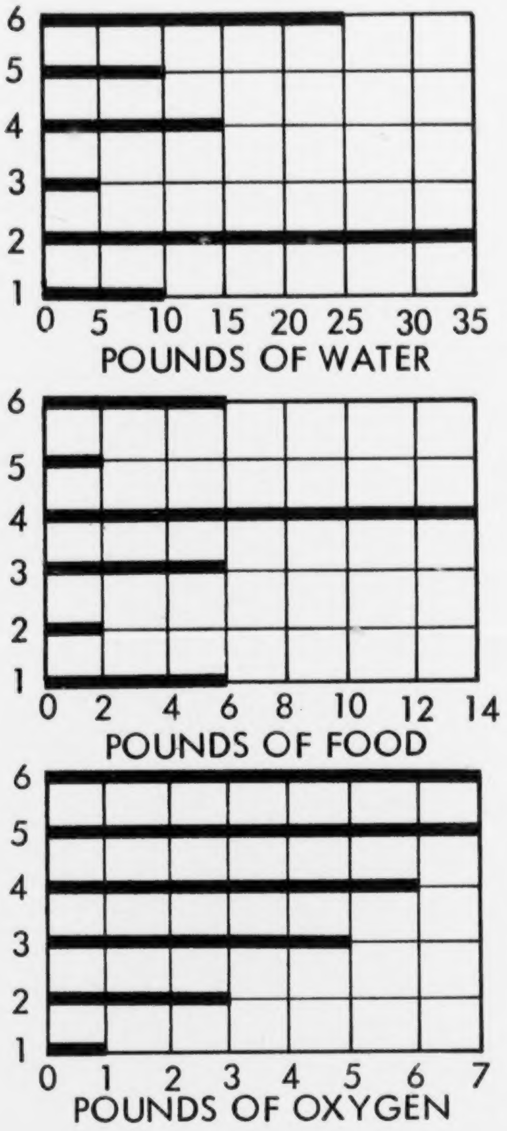
TEACHER'S GUIDE

1. Conduct a brief discussion on the things man absolutely needs to survive. After students establish that man's necessities include oxygen, food, and water, ask how these are provided to astronauts.
2. Ask how man's needs in an orbiting space station would be supplied, and establish the idea that materials must be brought up because the space station is "cut off" from the world.
3. Tell students they will compete in an exercise that deals with supplying a space station. Using an overhead projector, display the "Survival in Space" gamesheet, and explain how the competition will be run.
4. Students (each with his own gamesheet) are in one-to-one competition. Each pair of students has a single die. (If there is an extra student, he joins a pair, and that group becomes a three-way competition).
5. Explain what is shown on the gamesheet. There are three types of supply rockets that carry survival materials to the space station – one rocket delivers oxygen, another delivers food, a third delivers water. Each rocket flies along its own course. (Point out tracks.)
6. The object of the exercise is to see which player can deliver the greatest amount of materials to the space station. For each pair of players, there will be a winner. There will also be an overall class winner (the player with the largest score).
7. Each pair of players plays the game as follows: Each player rolls the die. High number goes first. The first players rolls, looks at the graph titled "Pounds of Oxygen," and copies the number onto the oxygen "track" on the gamesheet. (If the player rolls a "2" he copies "3" onto the track).
8. Each player rolls the die three times during his turn. The first time, he reads an oxygen value and enters it on the oxygen "track"; the second time he rolls, he reads a food value and enters it on the food "track"; the third time he rolls, he reads a water value and enters it on the water "track." After three rolls of the die, that player's turn is over, and the next player may roll the die three times.

9. When the players reach the space below the tally line, they total (on a sheet of scrap paper) the quantities written down thus far. This permits opponents to compare results up to that point. After comparing scores to that point, they resume the exercise.
10. When the players arrive at the space station ("End"), they add up all totals and show their scores to the teacher. The teacher records all totals to determine the overall game winner.
11. The game may be repeated using a fresh gamesheet.

SURVIVAL IN SPACE





THIRD THROW OF DIE

SECOND THROW OF DIE

FIRST THROW OF DIE

TALLY 1 O _____ F _____ W _____
TALLY 2 O _____ F _____ W _____
TALLY 3 O _____ F _____ W _____
END TALLY O _____ F _____ W _____
TOTAL O _____ F _____ W _____
GRAND TOTAL ____________________

Activity 2

Activity 5/6
THE HIP TOWN JUNK PROBLEM

SUMMARY

This activity is scheduled for two days.

Students perform simple arithmetic calculations on three imaginary methods for solving "Hip Town's" junk problem. Each student selects a method according to the criteria that define the best one. Enough information is given for the student to select the best of the three methods. Subjective information is added to complicate the selection.

Students are asked to form groups according to the method selected. Each group elects a leader, who speaks in favor of its method. With the teacher moderating, students have the opportunity to criticize and defend the various methods. Finally, a vote is taken, and the "best method" is selected. The teacher points out the differences between arguments based on quantitative (numbers) and qualitative (values) information as presented in the activity.

SOLO'S

1. The student can add columns of digits.
2. The student can compare numerical quantities written with either numbers or words.
3. The student can read a word problem and answer questions by checking "yes" or "no," or by writing numerical quantities.

MATERIALS

- Pencils

TEACHER'S GUIDE

1. Spend a few minutes discussing the problem of waste disposal in modern society. Ask students to tell what they know of the manner in which their city disposes of waste.
2. Ask students to speculate on how waste would be disposed of if society started generating huge quantities of waste. What could be done if we wore paper clothes that we threw away after one wearing? What could be done if we junked our cars after using them for only six months?
3. Tell students that this activity is based on such a problem in an imaginary place called Hip Town.
4. Pass out the Hip Town Junk Problem packet.
5. Have students read to themselves from items 1 through 10. Review with them what they are to do.
6. Have students do the arithmetic exercises on the page titled "Looking into Hip Town's Junk Problem." When all are ready, refer them to the next three pages (The Atom Smasher, Alum Rock Park, The Sea Monster). Have them fill in the bottom of each sheet.
7. After all students have filled in the three pages, ask them to decide which group they wish to join. Separate the groups (have students carry their activity packets with them).
8. Have each group elect a leader to speak for its method.
9. After each leader has spoken, open a discussion and encourage debate.
10. Only one method (The Sea Monster) satisfies all the criteria for the best method. The Sea Monster method is best because it is fastest and cheapest. All arguments based on qualitative data (such as value judgments) are beside the point.
11. Ask students to vote on the best method. Point out the rationale for selecting the Sea Monster as the best method.
12. If only two groups are formed, proceed as described above.
13. If all students select the same method, have students explain their reasons orally or in writing. Have selected students read their written compositions aloud. (If they have all picked a wrong method, use questions to help them discover the error.)

Activities 5 and 6

THE HIP TOWN JUNK PROBLEM

1. Hip Town is running out of dump space. Look at what is happening (Figures 5/6-1 and 5/6-2).

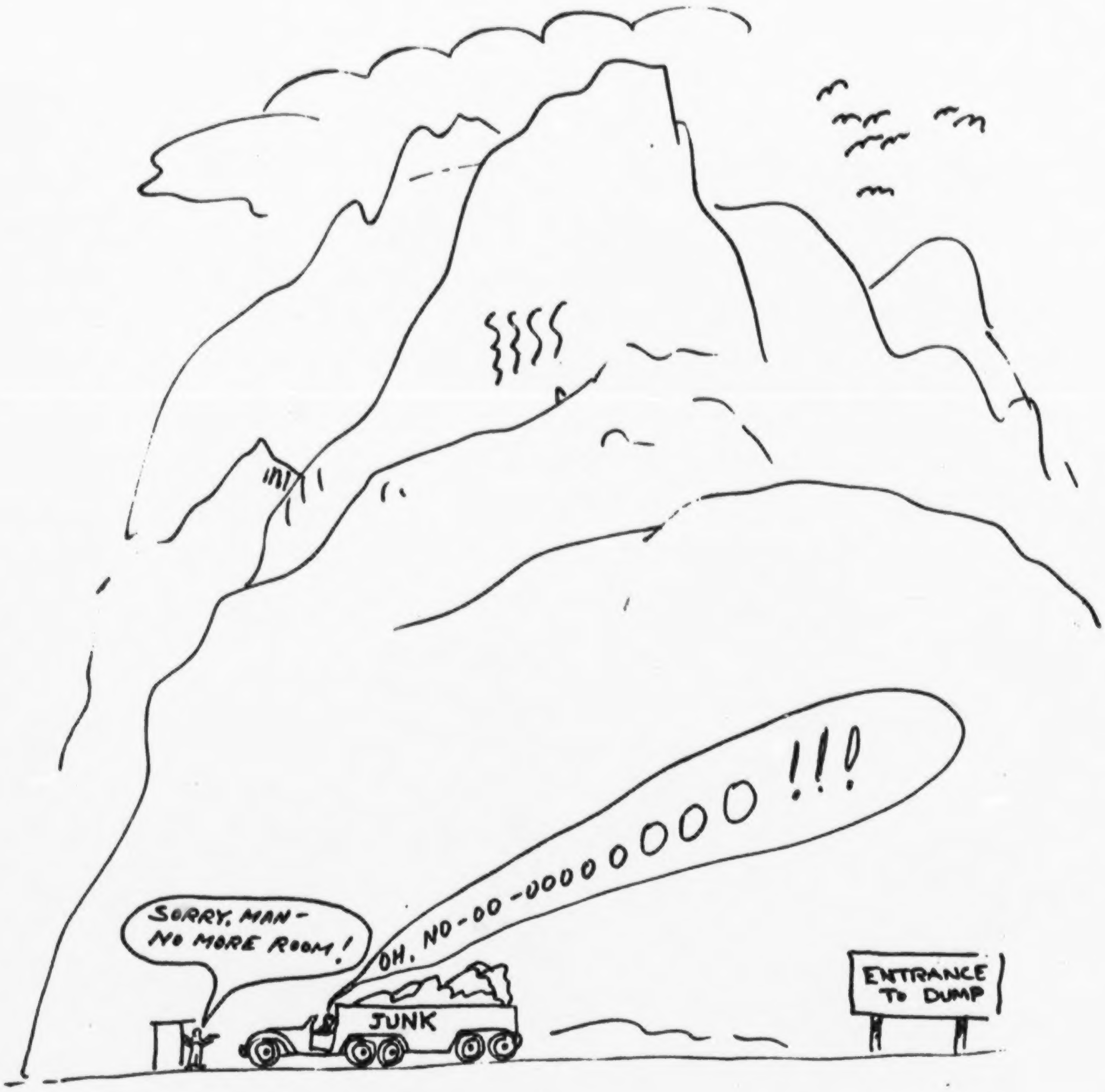


Figure 5/6-1 The Hip Town Dump

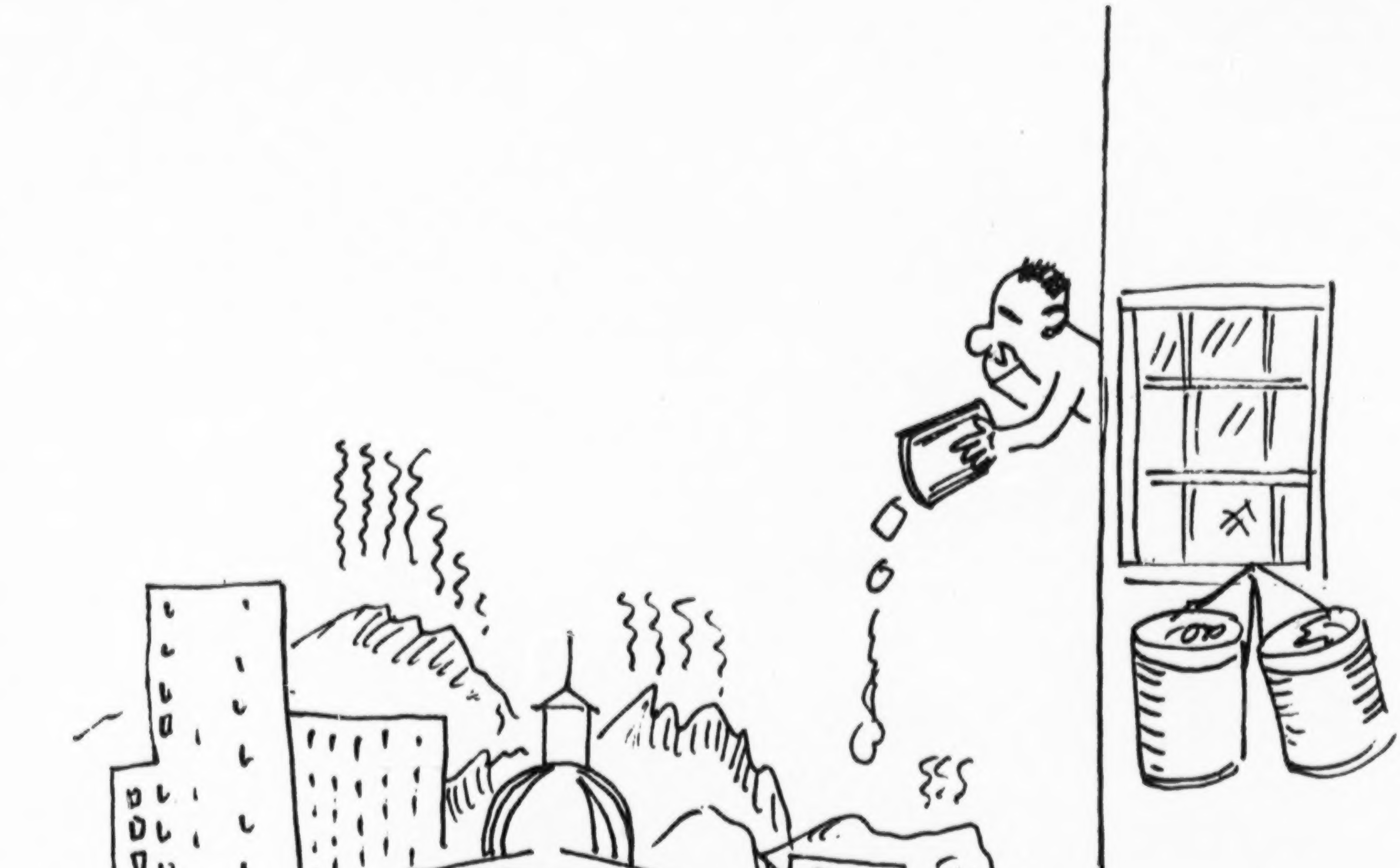


Figure 5/6-2 Hip Town Filled Up With Junk

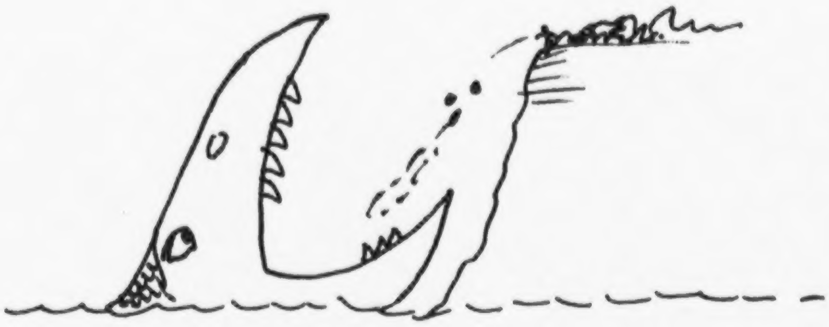
2. You must figure out what to do about the problem.
3. There are three different ways to solve the problem. You must pick the best one. Here are the three ways:

A. Use an atom smasher to turn the junk into electricity:

ZAP!
ZAP!
ATOM SMASHER

B. Fill up Alum Rock Park with the junk:

C. Feed the junk to the sea monster:



4. Each way has good points and bad points.
5. To find the best way, you must first look into the Hip Town junk problem.
6. Then you will be able to compare all three ways, and you will be able to pick the best one.
7. If you think the atom smasher is the best way, you will belong to the Atom Smasher Group. If you think filling up Alum Rock Park is the best way, you will belong to the Alum Rock Park Group. If you think the sea monster is best, you will belong to the Sea Monster Group.
8. Each group will elect a leader. The leader of each group will tell why its way is the best.
9. Everyone in the class may ask questions and speak up for his group's way.
10. When everyone has had a chance to talk, the whole class will vote for the best way.

BEFORE YOU CAN PICK A WAY OF GETTING RID OF THE HIP TOWN JUNK, YOU MUST LOOK INTO THE PROBLEM. START ON THE SHEET TITLED "LOOKING INTO HIP TOWN'S JUNK PROBLEM."

LOOKING INTO HIP TOWN'S JUNK PROBLEM

FIRST

Figure out how much junk is piled up in Hip Town. Hip Town must get rid of that junk.

- There are 500 tons of junk piled up all over Hip Town's streets.
- There are 1,500 tons of junk in the Hip Town dump.

TOTAL _____ tons of junk to get rid of

SECOND

Figure out how much junk is made in Hip Town each year.

10 tons of wrecked cars each year
10 tons of garbage each year
15 tons of ashes each year
5 tons of scrap paper each year
10 tons of broken bottles each year
TOTAL __ tons of junk made in Hip Town each year

THIRD

Fill in the blanks from the two TOTALS above

- Hip Town must get rid of _________ tons of junk.
- Hip Town makes _________ tons of junk a year.

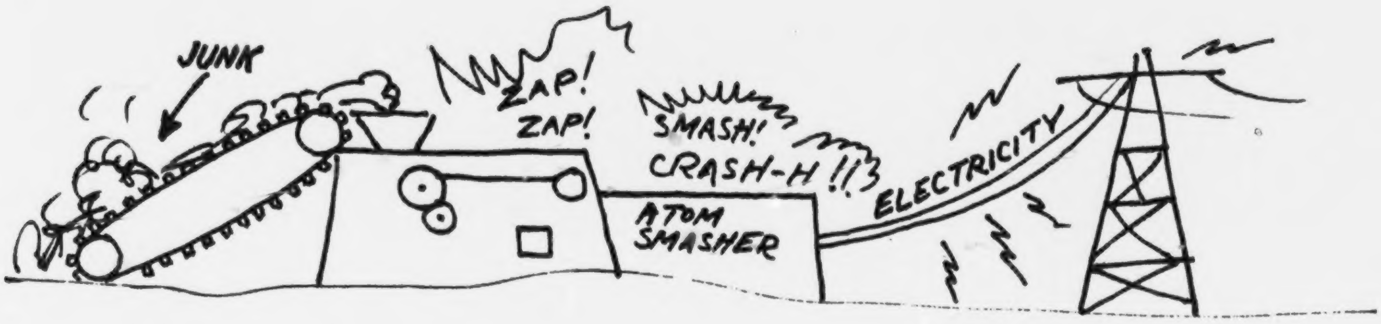
YOU WILL HAVE TO USE THESE NUMBERS LATER.

To solve the Hip Town junk problem, you must pick a way that:

(1) gets rid of all the junk piled up all over Hip Town's streets; and
(2) gets rid of the junk that Hip Town makes every year; and
(3) gets rid of all the junk in the fastest possible way; and
(4) costs the least money to get rid of all the junk.

THE ATOM SMASHER

Here is the Atom Smasher:


JUNK
ZAP!
ZAP!
SMASH!
CRASH-H !!
ATOM SMASHER
ELECTRICITY

FACTS ABOUT THE ATOM SMASHER

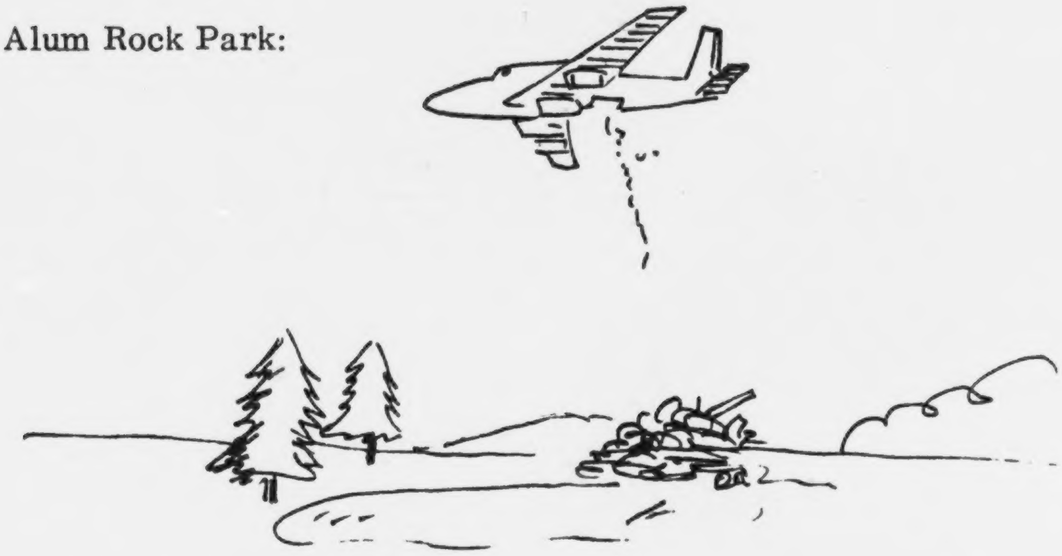
1. The Atom Smasher can take in junk and turn it into electricity.
2. The Atom Smasher costs $1 million dollars to build. It costs nothing to run.
3. The Atom Smasher can take in 55 tons of junk a year.
4. There is a volcano (mountain) nearby that blows up every few years. There is no way to know when the mountain will blow up.

NOW ANSWER THESE QUESTIONS:

1. Can the Atom Smasher get rid of all the junk piled up all over Hip Town's streets? ____ YES ____ NO
2. Can the Atom Smasher get rid of all the junk that Hip Town makes every year? ____ YES ____ NO
3. How much junk can the Atom Smasher take in each year? _________ TONS
4. How much does the Atom Smasher cost? _________ DOLLARS

ALUM ROCK PARK

Here is Alum Rock Park:



FACTS ABOUT ALUM ROCK PARK

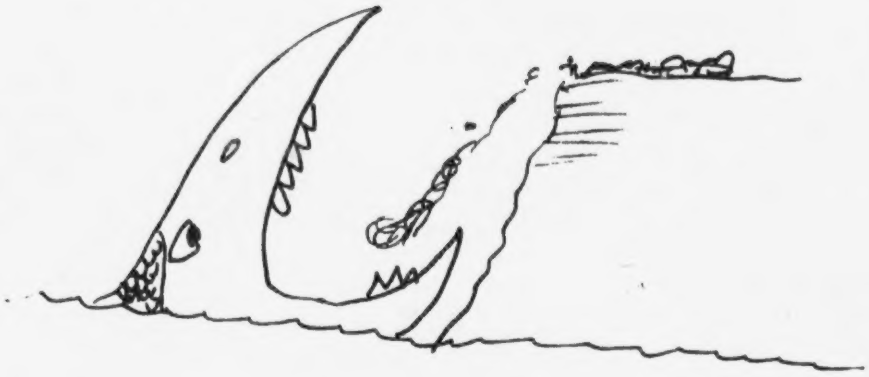
1. It would take five hundred years to fill up Alum Rock Park with all the junk made in the United States.
2. The airlines will carry Hip Town's junk and drop it into Alum Rock Park for $1,250,000.
3. The airlines (planes) can carry 50 tons of junk a year and drop it into Alum Rock Park.
4. If junk is dropped into Alum Rock Park, in five years it will smell so bad, you will never be able to go there and enjoy it.

NOW ANSWER THESE QUESTIONS:

1. Can Alum Rock Park be used to get rid of all the junk piled up over Hip Town's streets? ____ YES ____ NO
2. Can Alum Rock Park (and the planes) be used to get rid of all the junk that Hip Town makes every year? ____ YES ____ NO
3. How much junk can the planes drop into Alum Rock Park each year?
   _________ TONS
4. How much will it cost to use planes for dropping junk into Alum Rock Park?
   ____________ DOLLARS

THE SEA MONSTER

Here is the Sea Monster:



FACTS ABOUT THE SEA MONSTER

1. The Sea Monster loves to eat all kinds of junk.
2. When the Sea Monster is hungry, it can eat 1,000 tons of junk at one meal. The Sea Monster is very hungry every six months.
3. The Sea Monster can always eat 50 tons of junk a year.
4. It will cost one-half million dollars to carry junk to the Sea Monster.
5. Sometimes when the Sea Monster wants to have fun, it eats up an entire city such as San Diego or San Francisco. No one knows whether the Sea Monster is in a playful mood.

NOW ANSWER THESE QUESTIONS:

1. Can the Sea Monster get rid of all the junk piled up over Hip Town's streets?
   ____ YES ____ NO
2. Can the Sea Monster get rid of all the junk that Hip Town makes every year?
   _____ YES ____ NO
3. How much junk can the Sea Monster eat each year? _________ TONS
4. How much will it cost to use the Sea Monster for getting rid of Hip Town's junk? _________ DOLLARS

Activity 7

MOVING DAY FOR THE LEMMINGS

SUMMARY

The activity begins with a brief presentation by the teacher on the peculiar migratory trait of the lemming (a small, rat-like animal). Over population sometimes causes massive, swarming migration of lemmings as they search for food. Students perform a simple paper-folding exercise in which they count numbers of folds and numbers of rectangles produced in folding, and relate them to geometric population growth. Finally, students solve a graphic problem which poses an imaginary dilemma: Lemmings are depleting their food supply. Which generation will find it necessary to move in search of new food sources?

SOLO

The student can count and compare numbers of squares on grids.

MATERIALS

- Pencils
- Erasers
- Three identical Moving Day for the Lemmings gamesheets for each student

TEACHER'S GUIDE

1. Begin the activity with a brief description of the lemmings' search for food. The lemming is a small, rat-like creature that inhabits parts of Scandinavia. At times, huge numbers of lemmings have been observed rushing into the sea, to suicidal death. A steamship once reported it sailed for a quarter of an hour through several miles of lemmings swimming out to sea, where of course they drowned.

   In the 1500's, at the time the Spanish were exploring the New World, lemmings sometimes appeared in such large numbers in parts of northern Europe that people believed they had dropped down from the sky. The reason for the sudden appearance of huge numbers of lemmings is an unbalancing in the animal's natural surroundings. Lacking sufficient food and space, the lemmings move in a massive swarm over land and rivers. It is believed that they often mistake a coastal beach for another river to be crossed. The result is mass destruction, which balances the ecology for a time.

2. Tell students to place the sheet titled Guess the Number of Folds before them. Ask them to guess aloud how many times the paper can be folded in half; record each guess on the chalkboard. Tell students to begin folding the sheets (lined on one side) in half. (The connection to lemmings will be forthcoming.) An 8-1/2 × 11 sheet of paper can be folded (practically) only six times. This is the correct answer. Now ask the question: "How many rectangles have been made that are the same size as the folded up sheet?" Students may open the folded sheets, look at the printed sides and see that the ruled lines coincide with the fold lines. The number of rectangles is 64.

3. The relationship of six folds to 64 rectangles can be shown by overhead projection of the illustration titled Folding a Sheet of Paper. Here the teacher demonstrates how a simple folding process doubles the number of

rectangles with each fold. Students may refold their sheets to follow how this doubling process occurs.

4. The folding process can be used as a point of departure to explain how the lemmings sometimes find themselves pressed for feeding territory, which explains their swarming movements. Tell students to imagine a lemming population of two that doubles to produce four; that population doubles to produce eight, and so on.

5. At this point the teacher may state briefly the Malthusian Theory, which proposed that all animal life on earth is doomed to starvation because populations expand geometrically while food increases arithmetically.

6. Show students how to solve Moving Day for the Lemmings. Tell the students to place the sheet titled Moving Day for the Lemmings horizontally before them. On the left-side grid are two "1's." These stand for two lemmings. On the right is a supply of food for the two lemmings (also two "1's"). The numbers running upward (1 to 16) stand for generations. (Here it may be necessary to give a simple definition of "generation" as "the time in which children have been produced by a male and female lemming.") The first generation (1) is circled to show that we are in the first generation, starting with two lemmings that were produced by a male and female.

7. Explain the significance of the two sides as follows: The left-hand side will have lemmings added to it. The right-hand side will have food added to it. Lemmings will be added by always doubling the previous number. Added food will be shown by circling the next number in the vertical column. The illustration shows that two lemmings (on the left) have an entire row of food (on the right) available. Since one lemming consumes only one "square" of food, we see that in generation 1 there is more than enough food for the two lemmings.

8. To see what happens in the second generation, we circle the number 2. Any number of lemmings on the left-hand side may eat the food in rows 1 and two; but there must be one square of food available for each lemming. Now

we account for the lemmings in generation 2. To do so, we write in four 2's on the left-hand side. (Each time we add lemmings, we double the previous number (count) of lemmings of the previous generation.) The new number of lemmings is six.

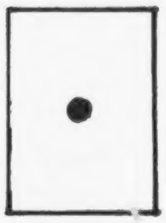
9. Now we must show the food needs of generation 2. The food needs of generation 2 are six squares. (We must feed the lemmings of generation 1 as well as the lemmings of generation 2.) To show the food needs of generation 2, we write six 2's in the food spaces. It is obvious that there is more than enough food in the food rows of generation 1 and 2 to feed the lemmings so far.

10. This process is repeated until it is seen that the food available in the generation number just circled (plus the food available from preceding generations) is not sufficient to feed the new number of lemmings.

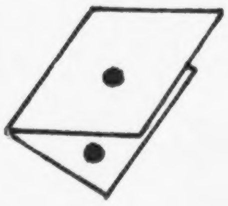
11. This critical point arrives in generation 5. Generation 5 is "moving day" for the lemmings, who must go in search of new sources.

12. Each student is supplied with two extra sheets to use if he mars his original exercise sheet.

FOLDING A SHEET OF PAPER

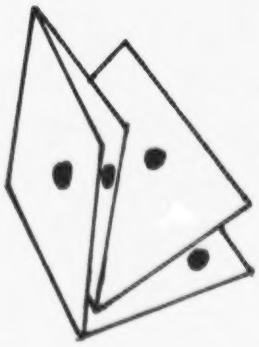


NO FOLDS
(1 RECTANGLE)



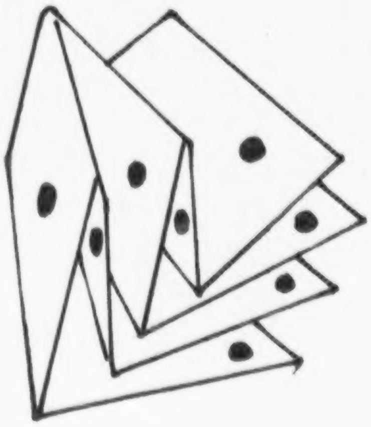
1 FOLD
(2 RECTANGLES)

1 FOLD
DOUBLES 1
= 2 RECTANGLES



2 FOLDS
(4 RECTANGLES)

2 FOLDS
DOUBLES 2
= 4 RECTANGLES



3 FOLDS
(8 RECTANGLES)

3 FOLDS
DOUBLES 4
= 8 RECTANGLES

AND SO ON

6 FOLDS
DOUBLES 32
= 64 RECTANGLES

MOVING DAY FOR THE LEMMINGS

Solution

Lemmings										Food for Lemmings																				Generation
																														16
																														15
																														14
																														13
																														12
																														11
																														10
																														9
																														8
5	5																													7
5	5	5	5	5	5	5	5	5	5																					6
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	⑤
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	④
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	③
3	3	3	3	4	4	4	4	4	4	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	②
1	1	2	2	2	2	3	3	3	3	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	①

SOLUTION: Lemmings _must_ move during the fifth generation

Activity 7

MOVING DAY FOR THE LEMMINGS

A lemming is a small animial that looks like a rat. Look at Figure 7-1, which shows millions of lemmings on the move. Can you figure out why they are moving? Your teacher will explain why.

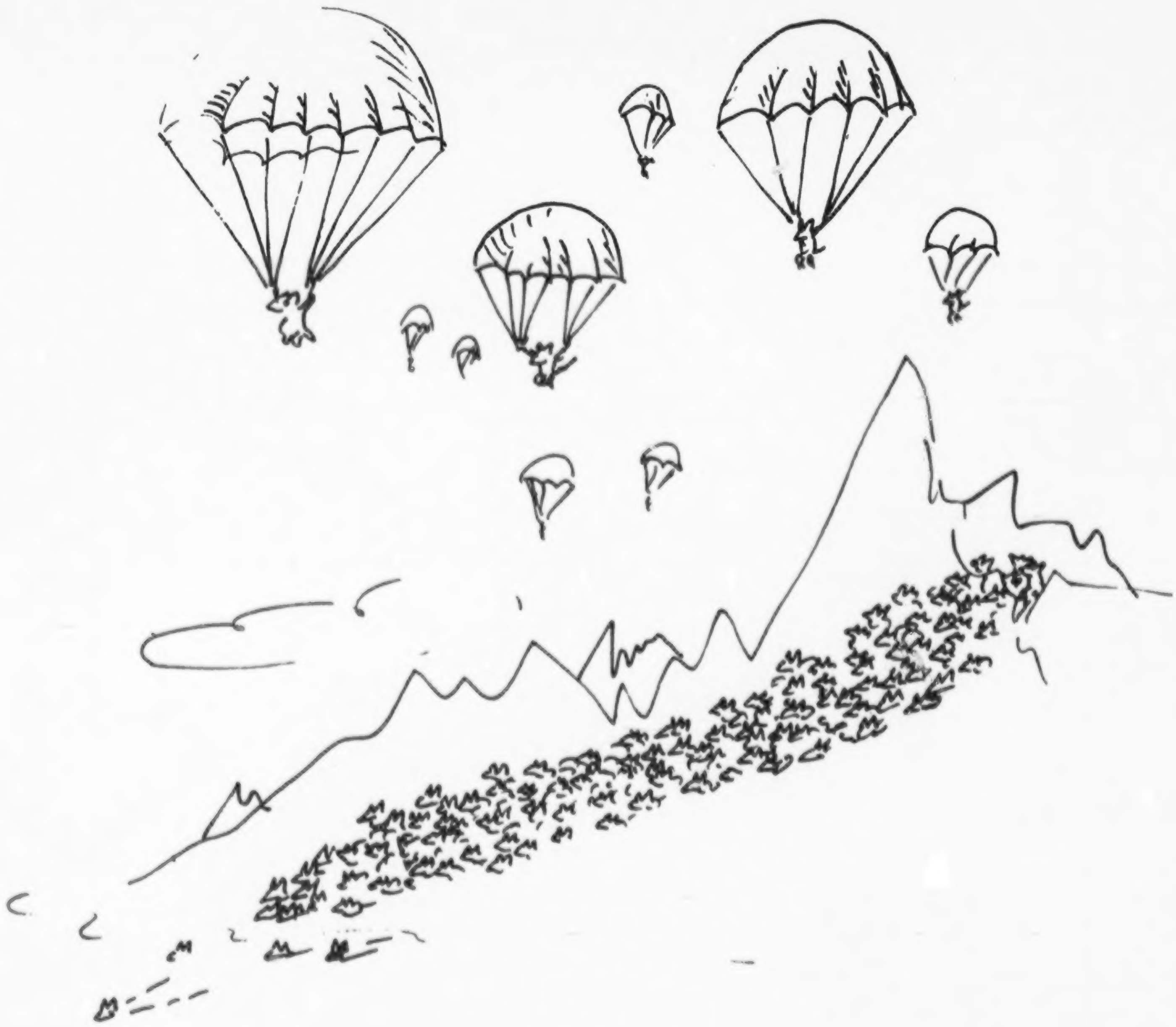


Figure 7-1 Lemmings on the Move

GUESS THE NUMBER OF FOLDS

(Fold Down On This Line First)

MOVING DAY FOR THE LEMMINGS

Problem

Lemmings										Food for Lemmings																				Generation
																														16
																														15
																														14
																														13
																														12
																														11
																														10
																														9
																														8
																														7
																														6
																														5
																														4
																														3
																														2
1	1									1	1																			①

QUESTION: In which generation must the lemmings move?

Activity 5
RACE TO THE HOSPITAL

SUMMARY

Students play a simple game which entails following directions that are presented both verbally and on an instruction sheet. The game also involves a numerical "look-up" table. The object of the game is to roll certain numbers on a die three times in a row. Students tally their results and compare them with chance. In a second round, students are told to concentrate on trying to achieve the desired die value. Again, they tally results and check to see whether or not concentration has produced higher scores.

SOLO

The student can use a simple "look-up" table.

MATERIALS

1. Student's Activity 5
2. Dice (1 per student)
3. Pencils

TEACHER'S GUIDE

1. Tell students that they are going to play a game called "Race to the Hospital," which is meant to show whether dice can be made to fall the way someone wishes them to fall.

2. Tell students to look at the cartoon figure titled RACE TO THE HOSPITAL. Tell students that the ambulance has a woman in it who is about to have a baby. The ambulance driver and doctor are rushing the woman to the hospital. But there are three problems in the form of three drawbridges. (Some students may need to be told that a drawbridge can be raised to let boats pass by. During that time, nothing can go over the bridge.)

3. If a boat is passing under the bridge, the ambulance driver will have to stop, and the baby will be born in the ambulance. This is perfectly all right, except that the mother would prefer to have her baby born in the hospital.

4. When students play the game, they will roll dice to tell whether the bridges are up or down. The ambulance must get over all three bridges in a row for the baby to be born in the hospital.

5. Explain how the game is played, referring students to INSTRUCTIONS AND SCORESHEET.

6. Each student has a single die, which he rolls, endeavoring to come up with three odd numbers in a row. Each time the student throws the die, he is at one of the drawbridges. If he throws an odd number, he can pass over the drawbridge. He must throw three odd numbers in a row to get over all three drawbridges and have the baby born in the hospital. If he does, he scores a check mark for that round.

7. If the student throws an even number, he is out--whether this occurs on the first, second, or third throw. He scores an X for that round, indicating that the baby was born in the ambulance.

8. Probability theory states that, if the chance of throwing an odd number (getting over one drawbridge) is 1/2 (there is an equal chance that the bridge is up or down), the total probability of throwing three odd numbers in a row (getting over three drawbridges) is:

$$1/2 \times 1/2 \times 1/2 = 1/8$$

In each set of eight rounds, therefore, there is only one chance that the ambulance will make it over all three drawbridges and that the baby will be born in the hospital. In all four sets of rounds (total of 32) there are four chances.

9. Tell the students that they should throw the die for a total of 32 rounds (see INSTRUCTIONS AND SCORESHEET). At the end of each set of eight rounds, they should count up the number of checks and write the number on the line.

10. Have students perform the activity independently.

11. When each student is finished and has summed his scores, he should know whether or not he scored higher than chance. The student is now ready for the second part of the experiment.

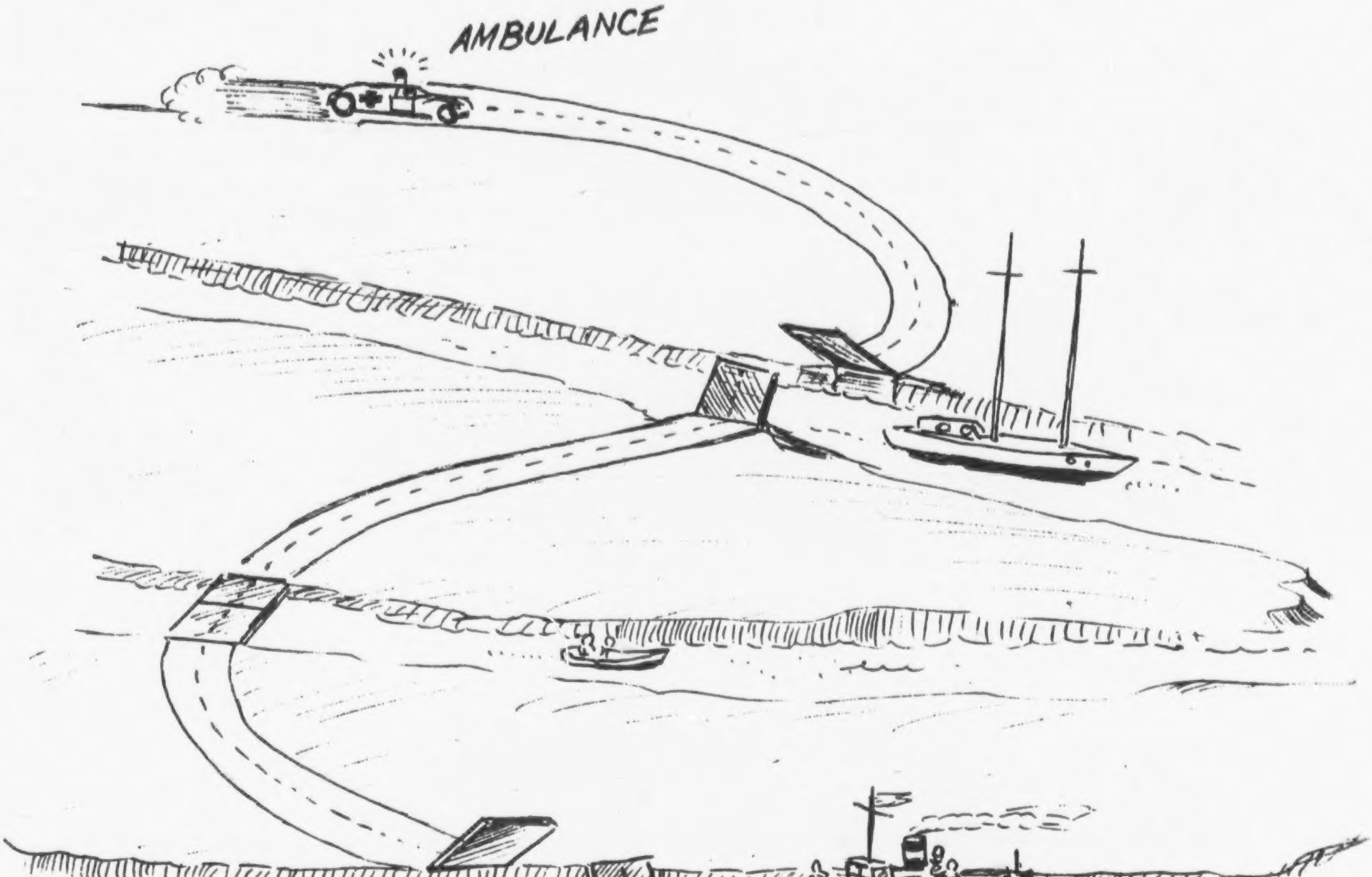
12. Using another SCORESHEET, each student should repeat the activity, while concentrating on throwing odd numbers.

13. After students have thrown the second set of 32 rounds and totaled their scores, have each one compare his score with the first set

of 32 rounds. How many did better the second time? If you wish, you may see who had the greatest increase.

14. Students who are especially fast should be allowed to complete a third set if they wish.

15. Complete the exercise with a statement that this was a demonstration of chance. For the type of problem that was described, the ambulance could be expected to get over all three drawbridges only one time out of eight. By throwing dice, students found out that they could not get through as often as they wished. The "concentration" part of the exercise was included so that students could see whether they performed better when they concentrated on throwing certain numbers.



RACE TO THE HOSPITAL

INSTRUCTIONS AND SCORESHEET

ROLL THE DIE

Odd numbers 1, 3, 5	Yes	You got over the drawbridge.
Even numbers 2, 4, 6	No	You did not get over the drawbridge.

GETTING OVER ALL THREE DRAWBRIDGES

1. Roll the die. You have three rolls in each round.
2. You must roll an odd number to get over the drawbridge.
3. If you roll three odd numbers in a row, the ambulance got over all three drawbridges.
4. If you throw an even number any time in a round, the ambulance did not get over all three drawbridges.

KEEP SCORE HERE

1. If the baby was born in the hospital (3 yeses in a row), make a check (✓).
2. If the baby was born in the ambulance, write an X.

Round No.	Round No.	Round No.	Round No.
1 ____	9 ____	17 ____	25 ____
2 ____	10 ____	18 ____	26 ____
3 ____	11 ____	19 ____	27 ____
4 ____	12 ____	20 ____	28 ____
5 ____	13 ____	21 ____	29 ____
6 ____	14 ____	22 ____	30 ____
7 ____	15 ____	23 ____	31 ____
8 ____	16 ____	24 ____	32 ____
How many checks out of 8? ____	How many checks out of 8? ____	How many checks out of 8? ____	How many checks out of 8? ____

Activities 12/13/14/15
CLASSROOM TEACHING CONTEST

SUMMARY

This is a four-day effort that places students in role-orientated teaching teams. Each team is given a set of materials to learn and discuss with one another. Following the discussion, each team member (whose responsibilities are spelled out in detail) prepares his part of the teaching job. After all the teams are ready, each team presents its lesson to the class. Since this is a competition, at the conclusion of all the lessons, each team tests the class on the materials that it taught. The team that elicits the largest number of correct answers is declared the winner. A follow-up discussion gives students the opportunity to critique their approach to teaching.

SOLC'S

1. The student can follow printed instructions.
2. The student can correctly answer four questions out of five on tests of specified complexity on:
    a. Map contour lines
    b. Area of a parallelogram
    c. Temperature conversion
    d. Torque

ROLES (EACH TEAM; FOUR TEAMS IN EACH CLASS)

* Team Teacher (Two):	Road lesson materials; decide how to teach lesson; work with other students who prepare chart(s) and one-page handout.
* Chart Maker:	Reads lesson materials; works with Team Teachers to prepare chart(s)
* Materials Specialist:	Reads lesson materials; works with Team Teachers to prepare one-page handout and five-question true-or-false test to be administered at end of simulation
* Scheduling and Supplies Specialist:	Reads lesson materials; obtains required materials from R-3 teacher and distributes it to team members; offers "fill-in" assistance to fellow team members.

STUDENT ACHIEVEMENT LEVELS

* All the roles require an ability to read at, or near, grade level.

* At least one of the Team Teachers should be a high-achieving student.

* Reading and arithmetic ability levels for the roles are as follows:

Team Teachers - Highest

Materials Specialist

Chart Maker

Scheduling and Supplies Specialist - Lowest

MATERIALS

1. Pencils
2. One set of student materials for each student. (Each student receives a set of instructions and a set of lesson materials. Instructions are the same for all students in the class. Each team member recives a set of lesson materials that are unique to his team.)
3. Five rulers (or straight edges), 12-inch
4. 10 sheets of chart paper
5. Five crayons (black, or dark color)
6. Approximately 20 sheets of 8-1/2" x 11" scrap paper
7. Access to reproduction machine (Xerox or other) for reproducing student-prepared one-page handouts and short tests. Total number of copies is 40.

RATIONALE

By actually involving themselves in the creative process of teaching, students should be motivated to learn the materials they are to present. The competitive aspect of the simulation should heighten students' desires to excel at their individual tasks.

Teacher Guide

1. This material should take four days. If time is available, the teacher may wish to schedule an additional day, or part of a day, to provide more time for review and class discussion.

2. The objective of this material is to give students the experience of preparing a lesson (from material that they read and learn), teaching it, and measuring effectiveness of their teaching. The emphasis is on team-work, and the R-3 teacher's role should be centered on "keeping students on the track." Each student's role is spelled out in his instructions. The teacher should ascertain that the lower achieving students understand their roles and are carrying them out.

3. The activities culminate in a student-administered test, which measures each team's teaching skill. The instructions call for the student to prepare a five-question true-or-false test on his team's material. The R-3 teacher should be highly critical of the student-prepared test. If the test does not appear to be reasonable, suggestions should be made to the student to change it. The test is reproduced by the teacher (20 copies) and returned to the student, who administers the test.

4. Begin the first day's activity by explaining the role of teaching as a public service profession in our society. The students probably have little awareness of the fact that in most countries of the world, educational opportunities are sparse or non-existent. Explain to the class that ours is one of the few countries in the world where unlimited educational opportunity is open to all people. Spend a few minutes asking students to conjecture what the United States would be like if public education were not available after the sixth grade, or if there were no public education whatever.

5. Stress the fact that in a democratic society where decisions are left to all the voting citizens, our quality of life depends directly on the people. A well-educated citizenry is essential in a democracy. Explain further that our society is becoming so complex that the ability of someone to meet society's needs is directly dependent on how much education he has.

6. Tell the class that the following activity will show them how information is conveyed through teaching. Point out that the information they will work with is typical of the kind that is taught in all technological societies.

7. Announce that the teaching simulations will take the form of a contest. The class will be divided into teams. Each team will consist of the following:

   One Chartmaker
   One Materials Specialist
   One Scheduling and Supplies Specialist
   Two Team Teachers

   (Information for teacher; Because the Team Teacher's roles are crucial there are two. This is to increase the chances that at least one will be present at school on the day the lesson is "taught." If necessary, one student can "double up" on the other roles.)

8. Tell the class that each student will be given a set of general instructions that tell how the Classroom Teaching Contest will be conducted. The instructions tell each student what he or she is to do, and how the team will work together.

9. In addition to the general instructions, each student will also receive a copy of the lesson materials that his team will learn and teach to the entire class. Explain that each team will have a different lesson. With four teams in the class, there will be four different lessons (on different subjects).

10. Explain that each team must work together to do a good job. Tell how the winning team will be selected: After all the lessons have been taught, each team will give a short test on its material to the entire class. The team that produces the largest number of correct answers will be the winner.

11. Go over the four-day schedule:

    Day 1 - Entire team reads and learns lesson that it will teach. Team discusses the lesson and what each member will do. Team starts preparing lesson.

    Day 2 - Team completes preparations and paper work. Material to be reproduced is turned over to R-3 teacher.

    (Information for teacher: Advance notice of the need for reproduction support should be furnished to the R-3 Project Office. Each R-3 class will require the reproduction of two masters, 20 copies each -- for a total of 40 reproduced pages.)

    Day 3 - All reproduced materials ready. Team Teachers teach lesson. Class tested.

    Day 4 - Continuation of lesson teaching and testing. Winner selected. Class review and discussion.

12. Divide the class into teams. Designate a high achiever as one of the Team Teachers; the other Team Teacher may be a low achiever. The result of this pairing should be beneficial. The least demanding role is that of Scheduling and Supplies Specialist.

13. Hand out packets of student materials. Encourage the teams to read the materials "on their own," and not to ask you for assistance unless they absolutely require it. Monitor progress and adherence to instructions.

CLASSROOM TEACHING CONTEST

____
(write your name here)

Instructions:

1. You are about to take part in a classroom teaching contest that will last four days.

2. The class will be divided into teams. Each team will prepare a lesson and teach it to the class.

3. Each member of the team will have an important job to do. To win the contest, your team will have to work together and do a good job.

4. After all the teams have taught their lessons, the best team will be selected as the contest winner.

5. You will be assigned a job with specific responsibilities. Check the name of your job:

_____Chart Maker

_____Materials Specialist

_____Scheduling and Supplies Specialist

_____Team Teacher (two in each team)

6. After you are assigned a job, turn to the next page.

YOUR JOB RESPONSIBILITIES

Instructions:

1. Place a check mark next to the job assigned to you.
2. Read your own job responsibilities.

Chart Maker:

1. Work with the two Team Teachers and agree on the chart or charts needed for the lesson.
2. Draw sketches of the chart(s) you plan to make.
3. Have the Team Teachers approve your sketches.
4. Draw Large Charts.

Materials Specialist:

1. Work with the Team Teachers, and prepare a rough draft of a handout (1 page). The handout should help the teachers to teach their lesson. It may have writing, pictures, or both.

2. After the Team Teachers approve your handout, have it reproduced (about 20 copies). Set the copies aside until the Team Teachers are ready to use them.

3. Prepare a 5-question true-or-false test on the lesson. Do not let anyone beside the Team Teachers see the test. You will give the test after the lesson has been taught.

Scheduling and Supplies Specialist:

1. Look at the following schedule, and make sure your team members follow it:

   Day 1 - Entire team reads and learns the lesson that will be taught. Team discusses the lesson and what each member is to do. Team starts preparing lesson.

YOUR JOB RESPONSIBILITIES, CONT'D

Day 2 - Team completes preparations and paper work. Materials Specialist's handout must be reproduced overnight. Tests must also be reproduced overnight.

Day 3 - 20 copies of Materials Specialist's materials ready. Chart(s) ready. Team Teachers ready to teach lesson. Materials Specialist's tests ready.

Team Teachers teach lesson. Materials Specialist gives test.

Day 4 - If your team did not teach its lesson on Day 3, it teaches the lesson on Day 4.

Class discussion of all lessons. Selection of winning team.

2. Make sure your team members have all the materials they need. Obtain the materials from your R-3 teacher. You will need the following for your team:
   - Pencils
   - Scrap paper for taking notes and making rough drafts.
   - One or two sheets of chart paper for the Chart Maker; crayons for the Chart Maker.
   - Ruler for Chart Maker's and Materials Specialist's sketches and drawings.

3. After Day 2's work is finished, turn over the Materials Specialist's handout page to your R-3 teacher for overnight reproduction. 20 copies are needed. Do the same with the Materials Specialist's test.

4. Be ready to offer help to your fellow team members.

Team Teacher (two in each team):

1. Decide with your fellow Team Teacher how the two of you will teach the lessons. Decide how you will divide the lesson, who will teach what. Each of you will have about 5 to 7 minutes to teach. (Total of 10 to 14 minutes.)

YOUR JOB RESPONSIBILITIES, CONT'D

2. The Scheduling and Supplies Specialist will make sure you will have all the supplies you need and will remind you of what must be completed each day.

3. The Chart Maker will draw charts that you may use.

4. The Materials Specialist will prepare a handout page that you may pass out to the class. This will make your teaching job easier.

HELPFUL HINTS

Instructions:

1. Place a check mark next to the job assigned to you.
2. Read the helpful hints for your job.

Chart Maker:

* Before you make a large chart, draw some small sketches. Make sure the sketch shows the main ideas of the lesson. You may wish to have the sketch (and chart) show an example. Decide with the Team Teachers.
* Draw the large chart so that everyone in the room can see the details and read the printing.
* Don't put too much detail on the chart.

Materials Specialist:

* Make a rough of your 1-page handout. It could show an outline of what the Team Teachers will teach. It could show a sketch, or an example worked out. It can have pictures or printing (or both). Decide with the Team Teachers what it should show. Do not copy the Chart Maker's chart.
* When you print the final copy, use a dark pencil, and press down hard. The final copy must be clear, since it will be reproduced by a copying machine.
* When you prepare your 5-question true-or-false test, take your questions out of the lesson material (that you will read). Make the questions short, but make sure they cover the main points of the lesson. If you let anyone other than the two Team Teacher's see your questions, the test will be useless. Print a clear copy of your test to be reproduced.

HELPFUL HINTS, CONT'D

Scheduling and Supplies Specialist:

- Give gentle reminders to your fellow team members about the schedule. Don't bug them.
- If your team is falling behind schedule, give help to get them on schedule.

Team Teachers:

- You may not read the lesson to the class. Take notes, and use them to teach the lesson. Use the handout to describe what you're teaching.
- Use the chalkboard and chart(s) to describe what you are teaching.
- Divide the work so that each of you teaches part of the lesson.

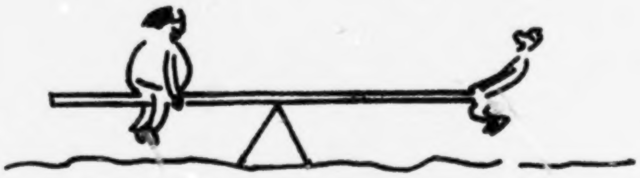
TORQUE (pronounced "tork")

Instructions;

1. All team members read this lesson. This is what you will teach to the class.
2. After everyone on your team has read it, discuss it with one another. Decide how the material should be taught.
3. Do not copy anything word-for-word or line-for-line. Take the information you need and make notes or sketches.

Everyone has been on a "see-saw" or "teeter-totter" as a child. Can you remember how you had to move up and down along the board to make it balance?

Does not Balance



Does Balance

By simply sliding along the board, you could find the position which made the board balance. Without knowing it, you were demonstrating an idea in the field of physics. The idea is called "torque" (pronounced "tork," like "pork"). A torque is a force that causes rotation. Here are some other examples of torque:

When we wish to measure a torque, we have to know two things:

1. The amount of force (usually in pounds)
2. The distance from the balance point (inches or feet)

Torque is equal to force times distance. Look at the cartoon above.

If the heavy student weighs 200 pounds and is 9 feet from the center of the see-saw, how much torque does he set into operation?

Torque = force x distance
= 200 lb x 9 ft
= 1800 lb-ft (Notice the units for torque, pound-feet.)

The light student weighs 80 pounds and is 10 feet from the center of the see-saw. How much torque does he put into operation?

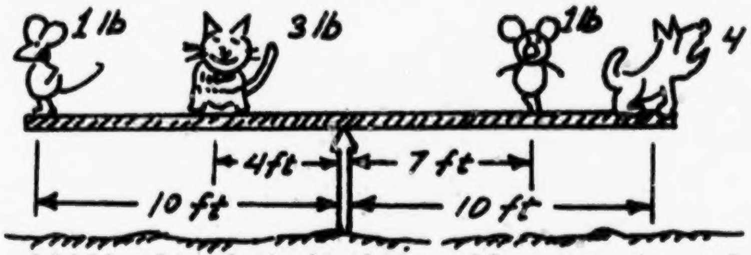
Torque = force x distance
= 80 lb x 10 ft
= 80 lb-ft

Now you are ready to notice something interesting about torque. You know how to measure torque (multiply force times distance). You must know how the forces move. On a see-saw if the heavier weight is on the left, the rotation (circular movement) is counter-clockwise:

If the heavier weight were on the right, the movement would be clockwise.

* * *

With this knowledge about torque, you should be able to solve this problem:



WHICH WAY WILL THE SEE-SAW GO?

Clockwise or Counter-clockwise?

This looks very difficult, but it is really easy to solve:

1. Add up the torques on the left. Remember, torque = force x distance.

   1 lb x 10 ft = 10 lb-ft
   3 lb x 4 ft = 12 lb-ft
   22 lb-ft in a counter-clockwise direction

2. Add up the torques on the right.

   1 lb x 7 ft = 7 lb-ft
   4 lb x 10 ft = 40 lb-ft
   47 lb-ft

3. Compare torques. The see-saw will move in the direction of the greater torque. Of course, it moves clockwise.

Unit 4

TEMPERATURE CONVERSION

Instructions:

1. All team members read this lesson. This is what you will teach to the class.
2. After everyone on your team has read it, discuss it with one another. Decide how the material should be taught.
3. Do not copy anything word-for-word or line-for-line. Take the information you need and make notes or sketches.

Everyone knows what "temperature" means. The word "conversion" means change, or changing. The expression "temperature conversion" means changing from one type of temperature scale to another.

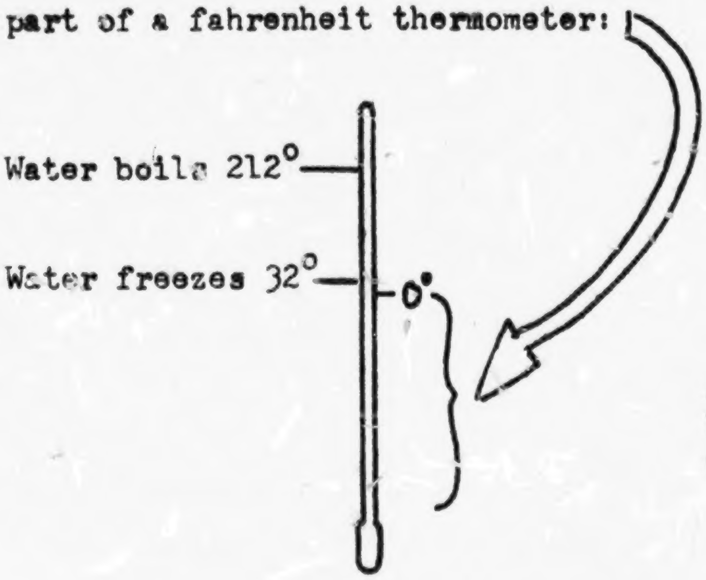
In the United States we use two types of temperature scales. One is called the fahrenheit scale. The other is called the centigrade scale. Here are the differences:

Fahrenheit Scale	Centigrade Scale
* Use by almost everyone.	* Used mainly by scientists.
* One the fahrenheit scale, water boils at 212 degrees.	* The word "centigrade" contains the word "cent," which means 100.
* On the fahrenheit scale, water freezes at 32 degrees.	* On the centigrade scale, water boils at 100 degrees.
* Invented by a German scientist named Gabriel Fahrenheit, who died in 1736.	* On the centigrade scale, water freezes at 0 degrees.
	* Invented by a Swedish astronomer named Celcius, who died in 1744.

Here are a few temperatures for comparison

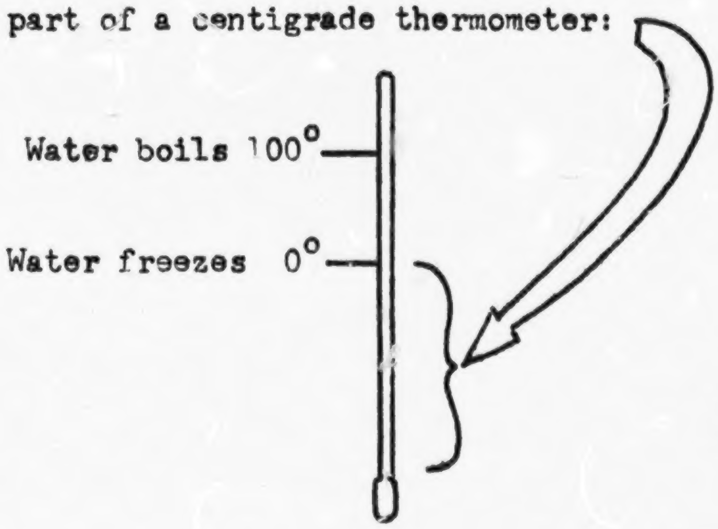
	Fahrenheit Scale	Centigrade Scale
Normal body temperature	98.6 degrees	37 degrees
Very hot day in San Jose	102 degrees	39 degrees
Very cold day in San Jose	40 degrees	4.5 degrees

You should also know something about the meaning of the words "below zero." Here is the below zero part of a fahrenheit thermometer:



All temperatures below 0 are written with a minus sign.

Here is the below zero part of a centigrade thermometer:



All temperatures below 0 are written with a minus sign.

Sometimes it is necessary to change from one temperature scale to another. This is called "temperature conversion," and it is very easy to do. You simply use this equation and "plug in" a number:

$F = \frac{9}{5} C + 32$ (This means that if you know a centigrade temperature, you multiply it by $\frac{9}{5}$ and add 32. Your answer is that same temperature on the fahrenheit scale.)

Here is an example: Something is at a temperature of 200 degrees centigrade. What is its temperature on the fahrenheit scale?

$F = \frac{9}{5} C + 32$ $F = \frac{9}{5} (200) + 32$ $F = \frac{9}{\cancel{5}} \overset{40}{\cancel{(200)}} + 32$ F = 392 answer

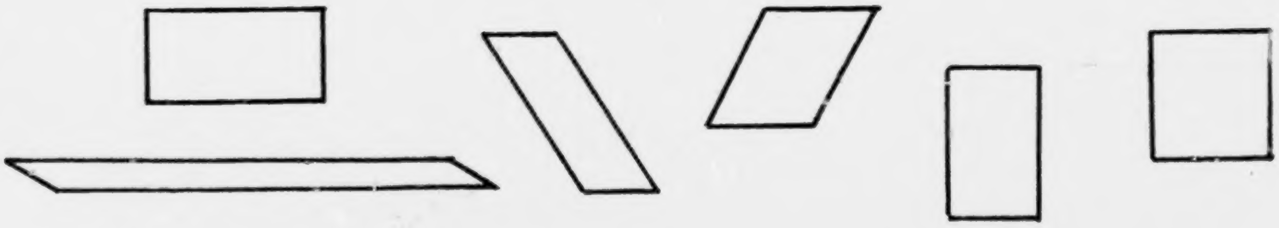
$$\begin{array}{r} 40 \\ \times 9 \\ \hline 360 \end{array} \qquad \begin{array}{r} 360 \\ +32 \\ \hline 392 \end{array}$$

FINDING THE AREA OF A PARALLELOGRAM

Instructions:

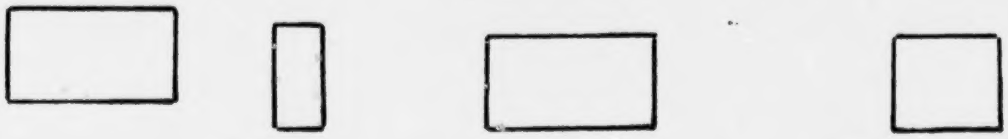
1. All team members read this lesson. This is what you will teach to the class.
2. After everyone on your team has read it, discuss it with one another. Decide how the material should be taught.
3. Do not copy anything word-for-word or line-for-line. Take the information you need and make notes or sketches.

Parallelograms are plane (two-dimensional, flat) figures that look like this:

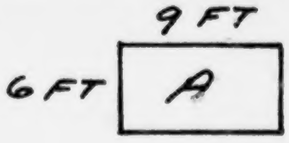


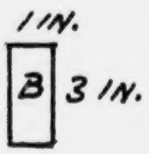
(Notice that one of the parallelograms is a square and two are rectangles.) You can see that in each case, a parallelogram has four sides, and the pairs of opposite sides are parallel (like railroad tracks).

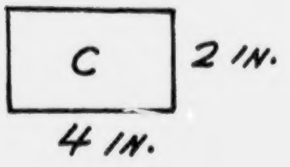
When a parallelogram happens to be a rectangle (four right angles), like this:

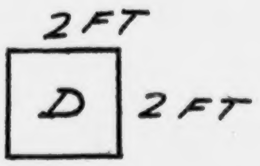


it is quite easy to find the area in the figure. All you do is multiply the length times the width, like this:





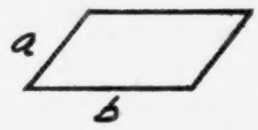


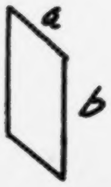


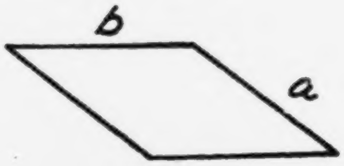
Areas

A=54 square feet
B= 3 square inches
C= 8 square inches
D= 4 square feet

To find the area of a parallelogram that looks like this:

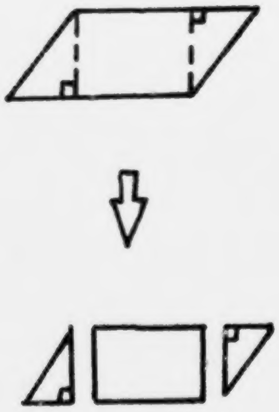


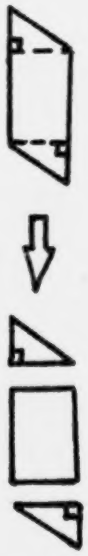


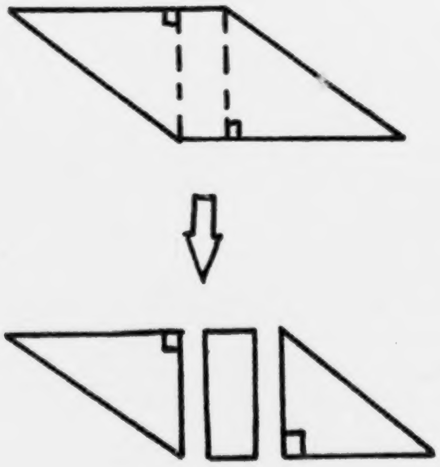


(These are not rectangles. You cannot find their area by multiplying side a times side b.)

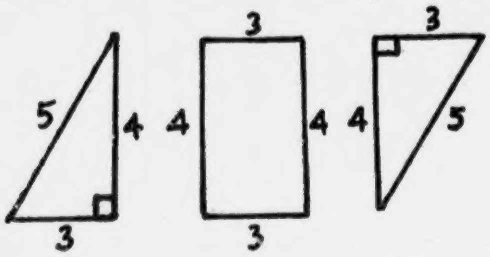
you must divide the figure into a rectangle and triangles. Here is how to do it:

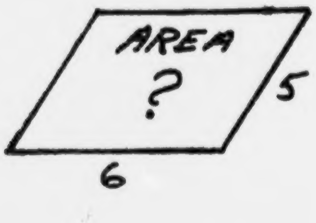






To find the area of the "broken up" parallelogram, simply find the area of the rectangle and add the area of the two triangles. Here is an example:





- * The rectangle part (center) is easy:
  3 x 4 = 12 units
- * The triangle parts (ends) are easy if you know how to find the area of a triangle:

Area of a triangle $= \frac{1}{2}$ base x altitude

$= \frac{1}{2} \quad 3 \times 4$

$= 6$ square units in each triangle

Total area of the parallelogram = 12 square units (rectangle)
6 square units (first triangle)
+ 6 square units (second triangle)
24 square units total area

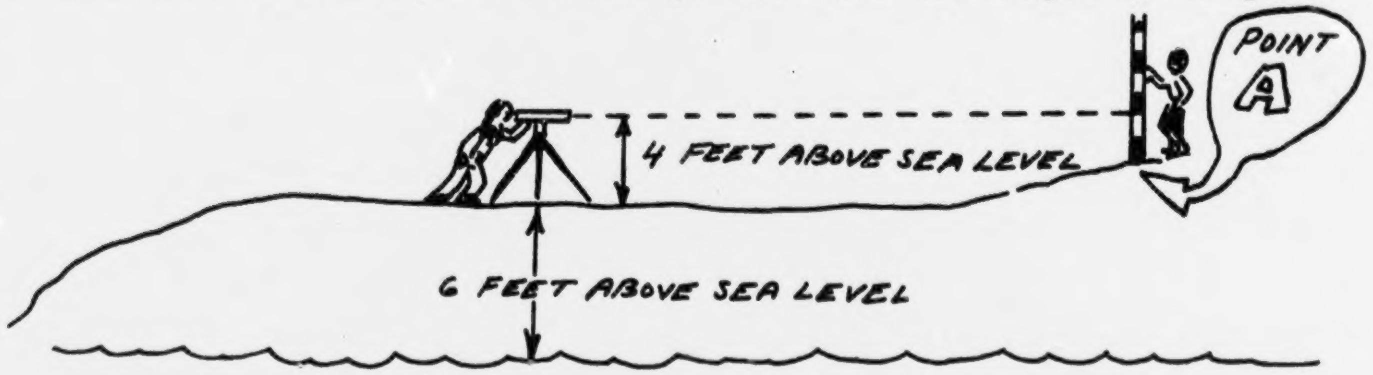
CONTOUR LINES ON A MAP

Instructions:

1. All team members read this lesson. This is what you will teach to the class.
2. After everyone on your team has read it, discuss it with one another. Decide how the material should be taught.
3. Do not copy anything word-for-word or line-for-line. Take the information you need and make notes or sketches.

Contour lines are curved lines on a map. Contour lines show the height of the ground above a certain level. If a map shows streets, roads, etc. but doesn't show contour lines, there is no way to know whether the ground is flat, hilly, mountainous, or depressed (valleys).

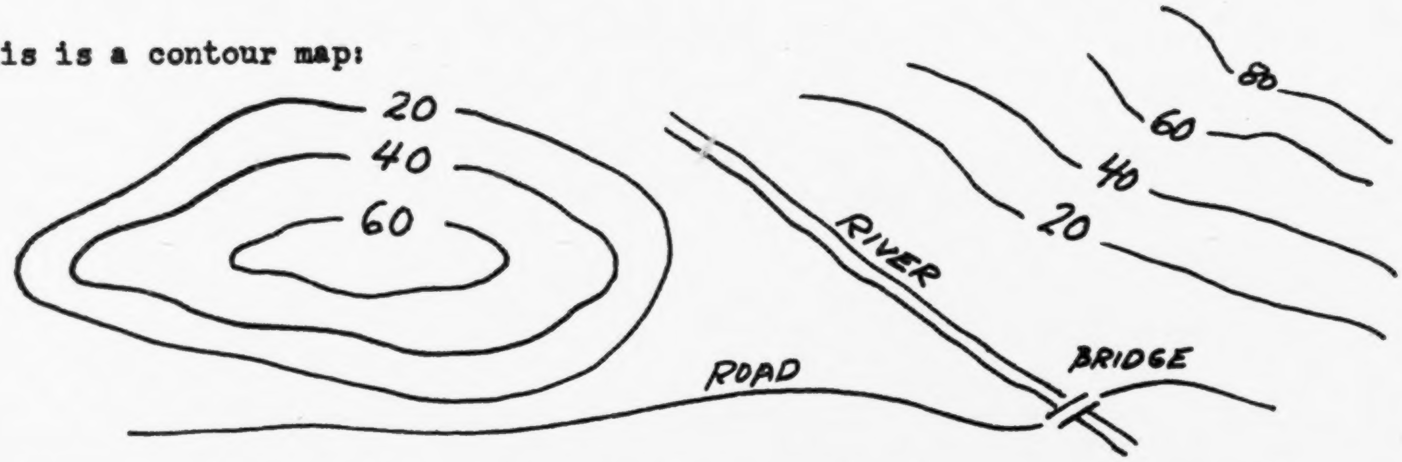
Contour lines are drawn from data collected by surveyors. Surveyors are people who go out with instruments that look like telescopes. If a surveyor knows the elevation (height above sea level) of the ground he is standing on, he can collect data for a contour map. He does this by having a man hold a special rod while he looks through the telescope and reads the height of the pole.



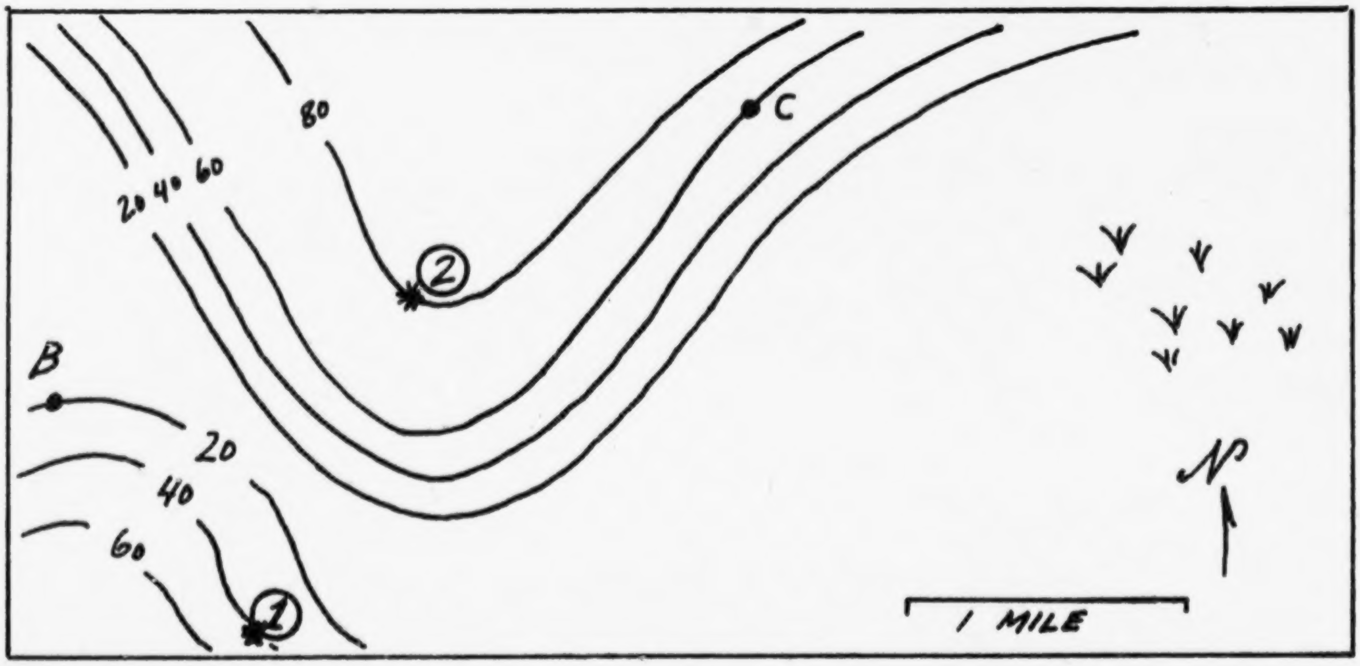
In this example, the surveyor knows he is 6 feet above sea level. He reads a height of 2 feet on the rod. He knows that point A is 8 feet above sea level. This height can now be put on a map. After thousands of points are collected and put on a map, the points can be connected. The connected lines are called "contours."

CONTOUR LINES ON A MAP, CONT'D

This is a contour map:



Contour maps show us what we can see if we are standing at a certain point. For example, suppose you are standing at point B. Can you see point C?



To get your answer, place a ruler or straight-edge on points B and C. You will see that the line ("line-of-sight") passes through a hill. People at B and C cannot see each other because of the height between. However, people at points 1 and 2 can see each other.

Contour maps are very important to anyone who must know about the elevation (height) of the land. Hikers, explorers, and rangers are especially interested in knowing the contour of the land.

Activity 9
SUBMARINE ESCAPE AND RESCUE

SUMMARY

This is intended as a follow-up activity to the field trip to Lockheed Ocean Systems, Sunnyvale. Students are assigned the roles of Technical Writer and Deep Submergence Rescue Vehicle Engineering Officer and complete writing and arithmetic exercises based on undersea rescue. The exercises are completed on an individual basis. The teacher may wish to have volunteers read compositions ("How the Submarine Escape Trunk Works") aloud.

SOLO'S

1. The student can write a short composition that describes a simple system whose operation has been portrayed to the student through illustrations.

2. The student can calculate the circumference of a circle by the equation circumference $= \pi D$ (or $2\pi R$)

MATERIALS

1. Pencils
2. One set of Activity 9 Student Materials for each student

Teacher Guide

1. Preferably, this activity should follow the field trip visit to Lockheed Ocean Systems, Sunnyvale. Start the activity be speaking for a few minutes on the importance of rescue systems for underwater operations. Point out that in addition to the need for rescuing seamen who are involved in disasters, there will be a growing need to plan for the rescue of aquanauts, as undersea research increases.

2. Tell the class that ever since men starting going beneath the sea in submarines, there have been disasters. By far, the largest number of submaring sinkings are caused by collisions at sea. Usually a ship rams into a submarine (often at night), sending the submarine to the bottom. Sometimes the collision is so serious that there is no hope, and all the crew is lost.

3. Point out that many different types of escape and rescue systems have been designed to save crews that become involved in such disasters. The Deep Submergence Rescue Vehicle is only one of a number of ways that have been provided.

4. Tell the class that when a submarine becomes involved in a disaster at sea, there are certain actions that are taken immediately. Sailors rush to close compartments that are flooded, to prevent the entire submarine from becoming flooded. Emergency lighting comes on. After the sub reaches the bottom, a door is opened, and a float (connected to the submarine by a line) rises to the surface. When the float reaches the surface, it starts to send out an emergency message, announcing "SUBSUNK" (Write the expression on the chalkboard) and giving the submarine's position (latitude and longitude). Hopefully, this message is picked up by ships and planes. In addition, the submarine may release smoke bombs that mark its position for searchers.

5. Emphasize to the class that a submarine disaster requires the greatest speed of response that people are capable of. Often when a submarine sinks, water enters the hull (body of the submarine) and compresses (squeezes) the air inside the submarine. This raises the pressure of the air, and the atmosphere becomes very painful.

6. Point out also that the submarine carries only a limited supply of oxygen. If this is used up, men may become ill or die of suffocation. Finally, mention the fact that as we breathe, we exhale carbon dioxide, which is poisonous in excessive amounts. Although submarines have equipment for purifying the air (removing carbon dioxide), after a long period of time, the purification screens become overfilled.

7. Tell the class that because of all these reasons, it is necessary rush all rescue operations.

8. Point out that in certain cases it becomes necessary for the crew to escape from the submarine rather than wait for rescue. There are several reasons why they may choose, or be forced, to do this:

   * The rescue equipment may not be available
   * The rescue equipment may break down on the way
   * The SUBSUNK emergency message may not have been received
   * The emergency on board the submarine may be so serious that the men cannot wait for rescue

9. Hand out the packets of Activity 9 Student Materials.

10. Tell the class to look at the illustrations on the first page. Tell them that the illustrations show a submarine escape system that can be used by sailors who wish to get to the surface on their own. Tell the class that when a sailor makes an escape from a submarine, he carries a special

breathing device (that resembles a gas mask). If the line between the submarine and the float (on the surface) is still intact, the escaping crewman can float to the surface by guiding himself up the line. This assures that he will come up at a controlled rate of speed and that he will be close to the float.

11. Start the class on the Submarine Escape exercise. This entails reading the instructions, studying the illustrations, and writing a brief composition on how the escape system operates.

12. In the pictured system, the escaping crewman is released directly to the sea are rises because of natural bouyancy. (In actual operation, the crewman would be equipped with a breathing device and possibly would ascend via a line. Also, operation of the escape trunk would be through controls, lines, valves, etc. which are not portrayed in the interest of keeping details to a minimum).

13. Some students may take exception to the sketch that shows flooding of the cabin by water being drained from the escape trunk. Point out that only a small amount of water enters the hull each time the trunk is used.

14. Ask for volunteers to read their compositions aloud.

15. For the remainder of the period, concentrate on the two arithmetic exercises. Encourage students to do these on their own. In the "Deep Submergence Rescue Vehicle Study," tell the students that the vehicle is an imaginary one, not the Lockheed DSRV (which dives to only 5000 ft).

16. Preface the "SUBSUNK !" exercise with a brief introduction to the "Survival Curve" at the lower-left-hand side of the page. Point out that this is an imaginary curve that is based on a real one. Ask students to conjecture on reasons why the percentage of saved crewmen falls off so quickly after 24

hours. Tell the class that since man is an air-breathing animal, he cannot survive for very long without a supply of reasonably pure air.

17. Circulate among students and offer help if they cannot proceed on their own.

TEACHER'S ANSWERS

DEEP SUBMERGENCE RESCUE VEHICLE STUDY

______________________ NAME

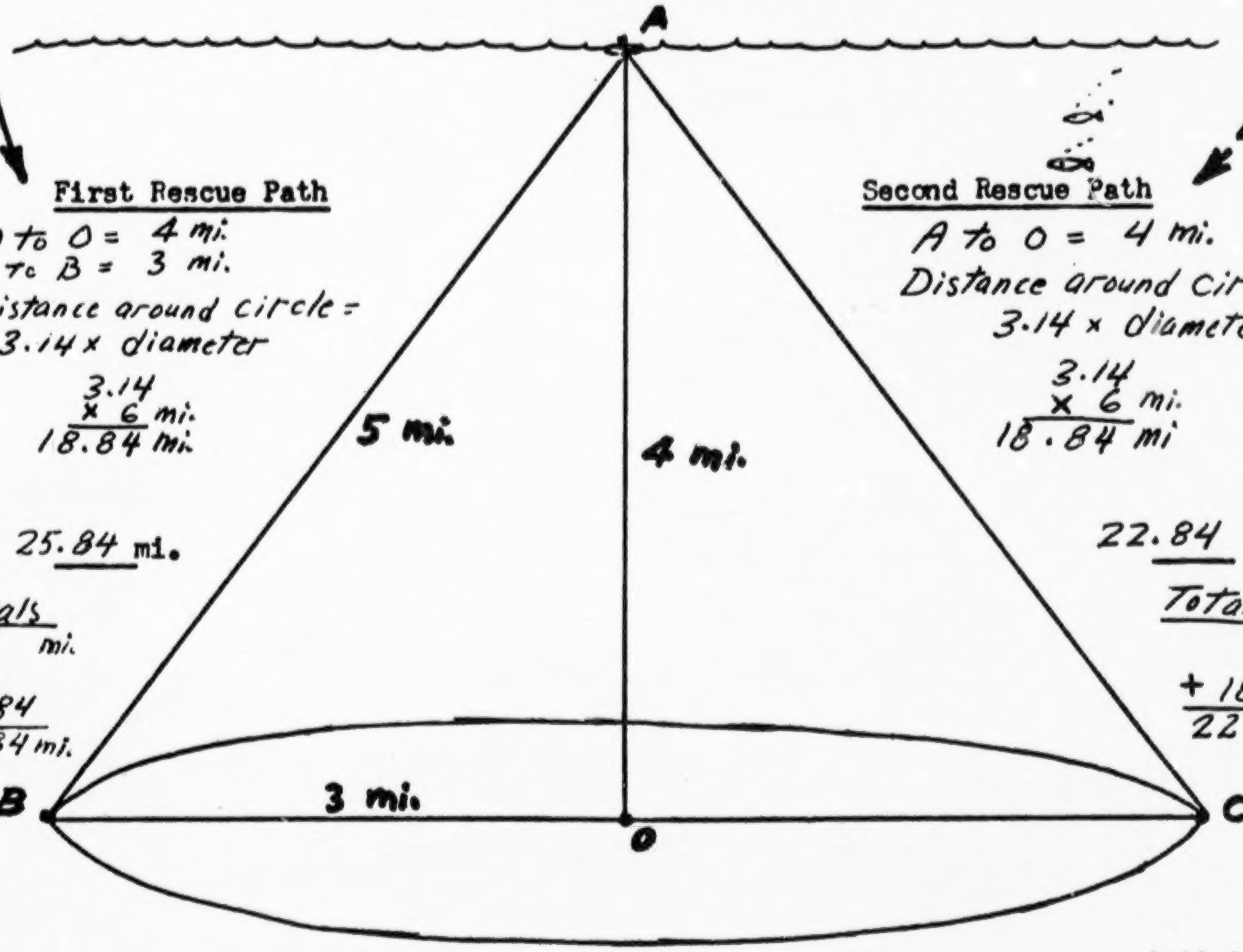
Instructions:

1. You are the Engineering Officer on board a Deep Submergence Rescue Vehicle.
2. Your job is to make sure the Rescue Vehicle is always ready to make emergency rescues.
3. You have been ordered to figure out two different kinds of rescue paths (see the figure below).

* In the first rescue path, the Rescue Vehicle will:
- a. Dive from point A to point O
- b. It will then travel from point O to point B
- c. It will then travel completely around the circle whose center is point O

* In the second rescue path, the Rescue Vehicle will:
- a. Dive from point A to point B
- b. It will then travel completely around the circle whose center is point O

4. Calculate the distances for both paths. Do your work on this page.
5. Note: Circumference (distance around) of a circle equals 3.14 x diameter.



First Rescue Path

A to O = 4 mi.
O to B = 3 mi.
Distance around circle = 3.14 × diameter

$$\begin{array}{r} 3.14 \\ \times\ 6 \text{ mi.} \\ \hline 18.84 \text{ mi.} \end{array}$$

25.84 mi.

Totals

$$\begin{array}{r} 4 \text{ mi.} \\ 3 \\ +18.84 \\ \hline 25.84 \text{ mi.} \end{array}$$

Second Rescue Path

A to O = 4 mi.
Distance around circle = 3.14 × diameter

$$\begin{array}{r} 3.14 \\ \times\ 6 \text{ mi.} \\ \hline 18.84 \text{ mi} \end{array}$$

22.84 mi.

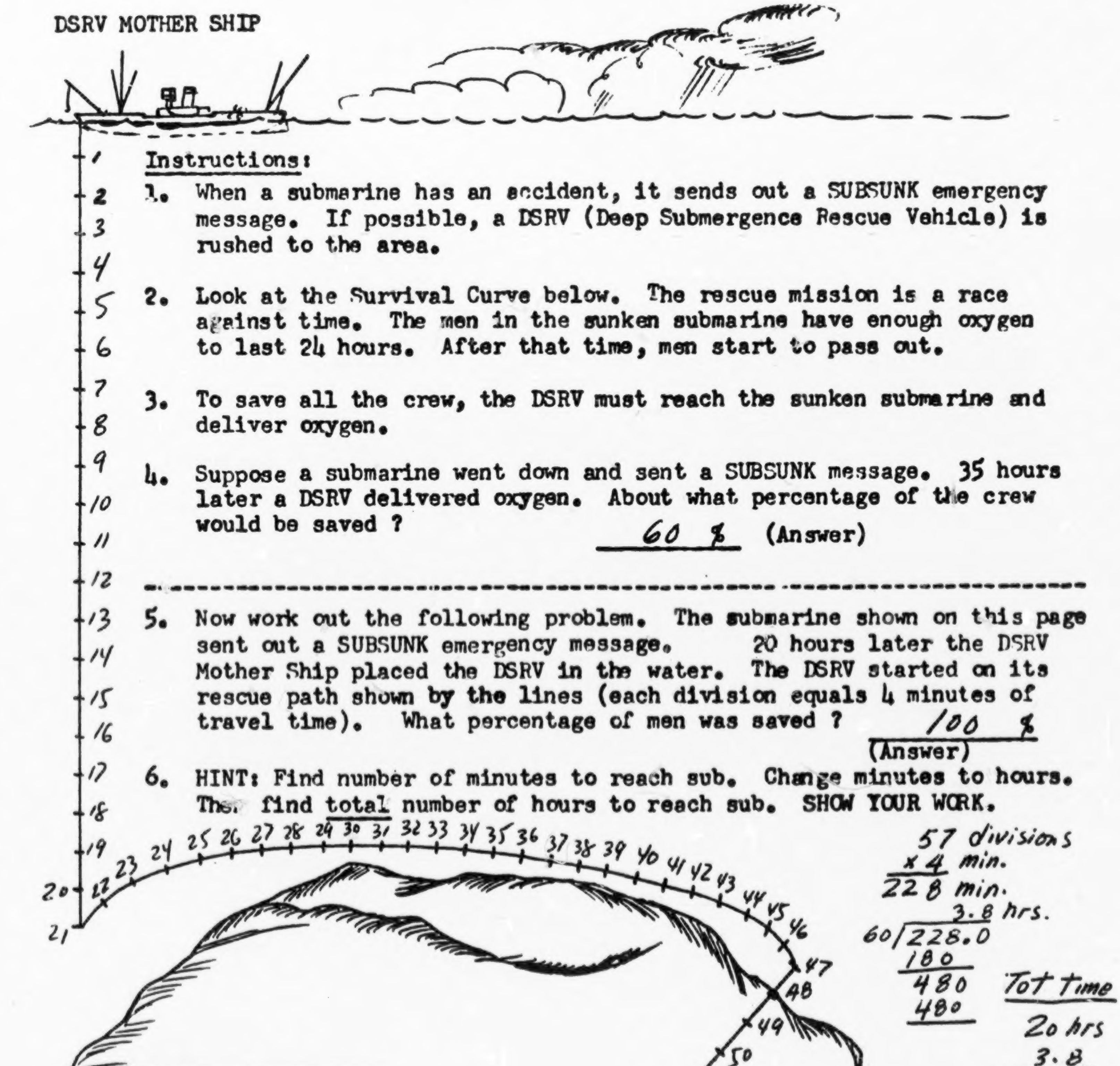
Totals

$$\begin{array}{r} 4 \\ +18.84 \\ \hline 22.84 \text{ mi.} \end{array}$$

Unit 5

TEACHER'S ANSWERS
SUBSUNK !

NAME



Instructions:

1. When a submarine has an accident, it sends out a SUBSUNK emergency message. If possible, a DSRV (Deep Submergence Rescue Vehicle) is rushed to the area.

2. Look at the Survival Curve below. The rescue mission is a race against time. The men in the sunken submarine have enough oxygen to last 24 hours. After that time, men start to pass out.

3. To save all the crew, the DSRV must reach the sunken submarine and deliver oxygen.

4. Suppose a submarine went down and sent a SUBSUNK message. 35 hours later a DSRV delivered oxygen. About what percentage of the crew would be saved ? 60 % (Answer)

---

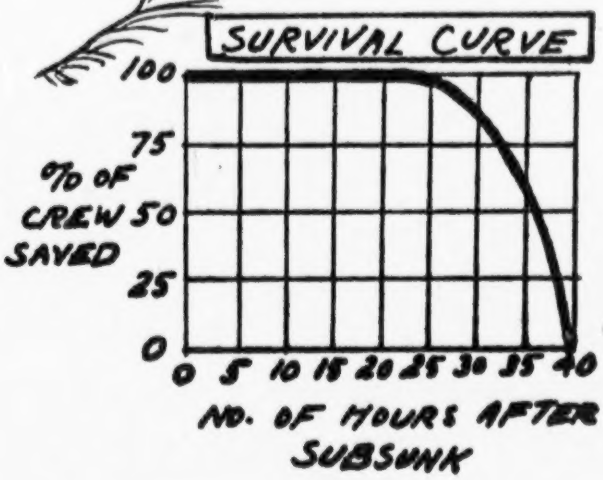
5. Now work out the following problem. The submarine shown on this page sent out a SUBSUNK emergency message. 20 hours later the DSRV Mother Ship placed the DSRV in the water. The DSRV started on its rescue path shown by the lines (each division equals 4 minutes of travel time). What percentage of men was saved ? 100 % (Answer)

6. HINT: Find number of minutes to reach sub. Change minutes to hours. Then find total number of hours to reach sub. SHOW YOUR WORK.

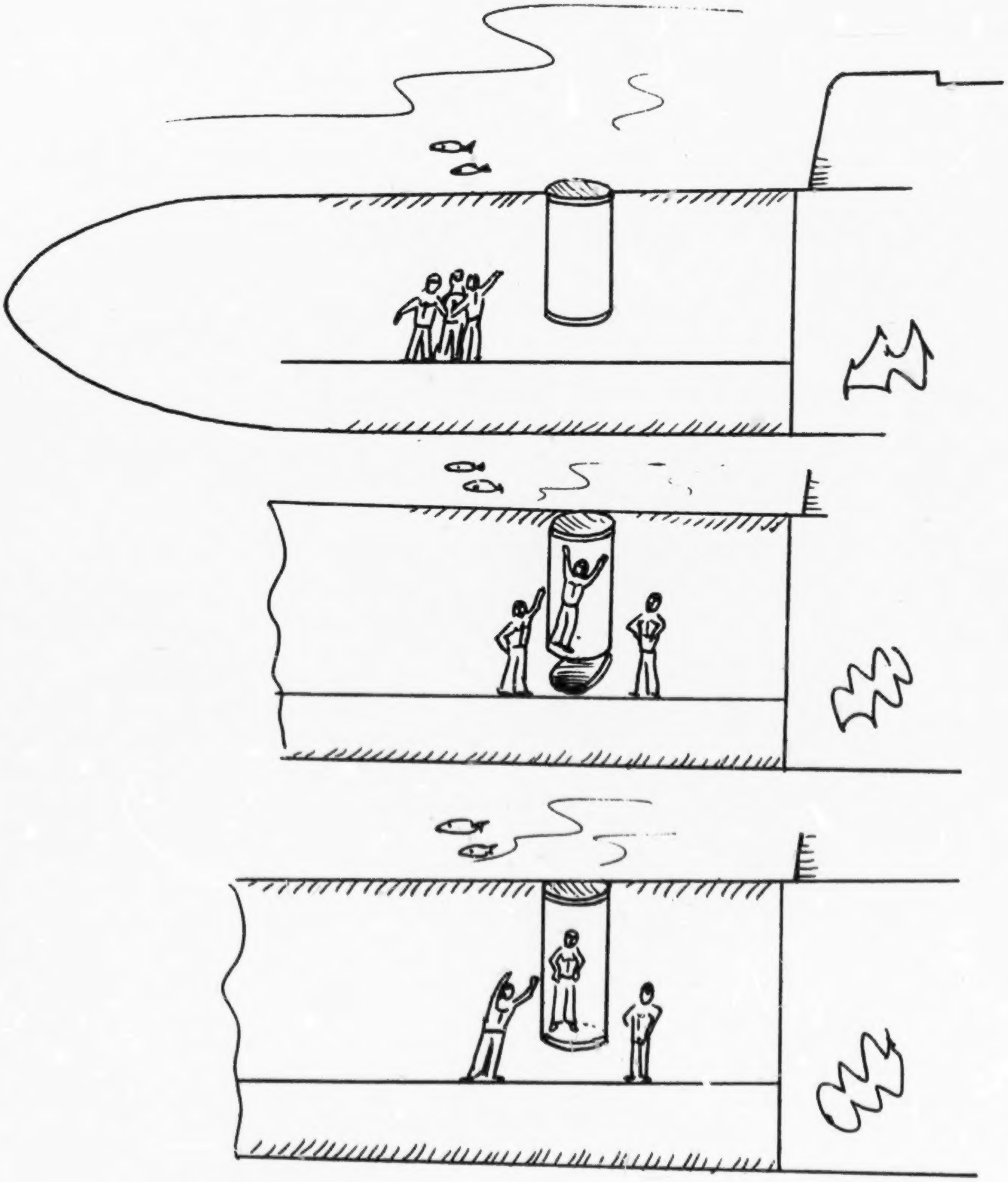
57 divisions
x 4 min.
228 min.

$$60\overline{)228.0} = 3.8 \text{ hrs.}$$
180
480
480

Tot Time
20 hrs
3.8
23.8 hrs



SUBMARINE ESCAPE
SHEET 1



Instructions:

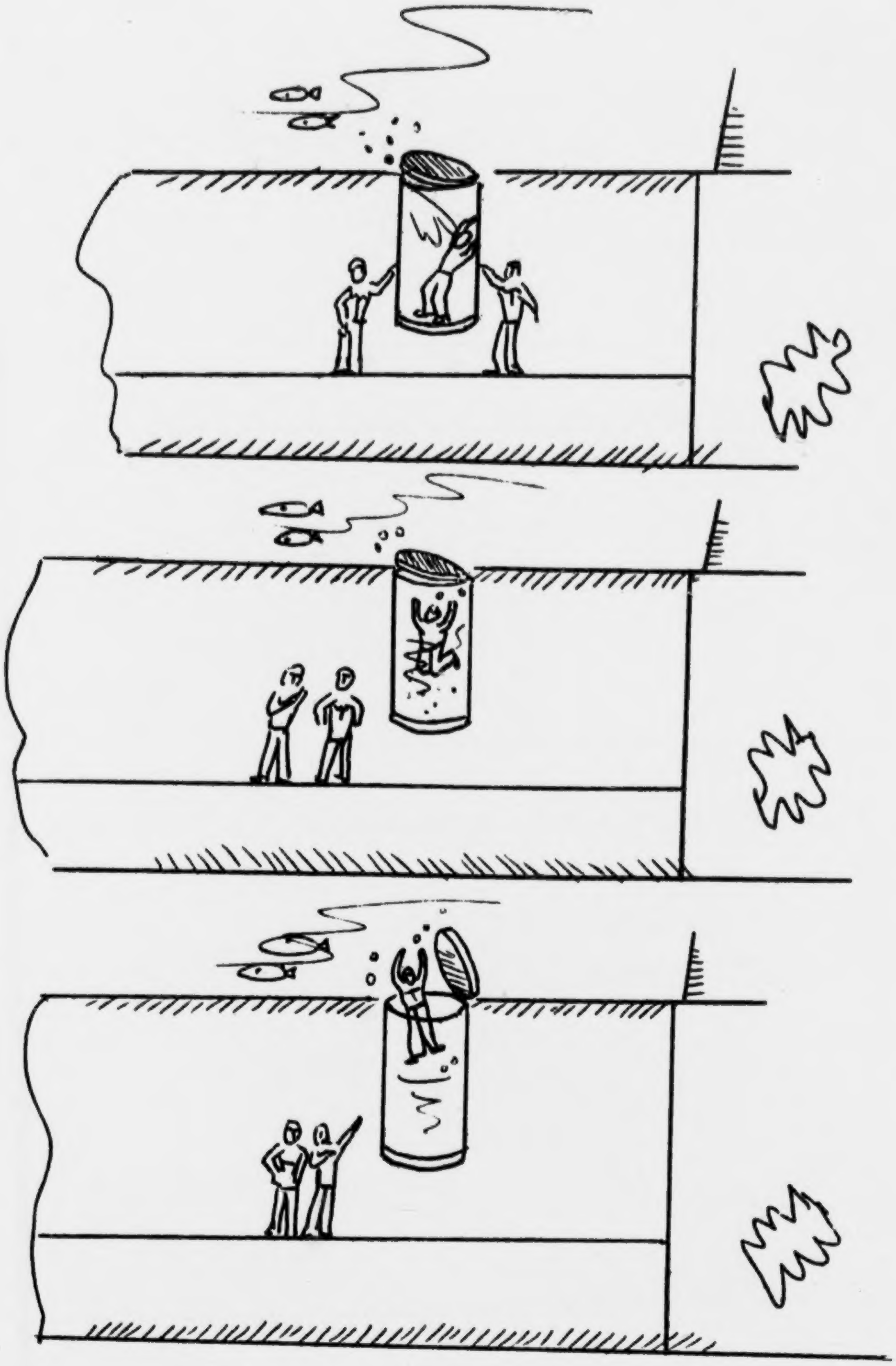
1. You are a Technical Writer. A Technical Writer investigates a subject and writes handbooks, reports, and other types of documents on the subject. Both men and women work as Technical Writers.

2. Your job is to write a description of how a submarine escape system works.

3. Look at the illustrations on this page and on the following pages. Try to understand what is happening in the pictures. You will need to know a few technical words: (1) the object that looks like a tin can (cylinder) is called an "escape trunk"; (2) the circular doors at the top and bottom of the escape trunk are called "upper hatch" and "lower hatch"; (3) the people in the sunken submarine are called "crewmen."

(CONTINUE READING NEXT PAGE)

SUBMARINE ESCAPE
SHEET 2



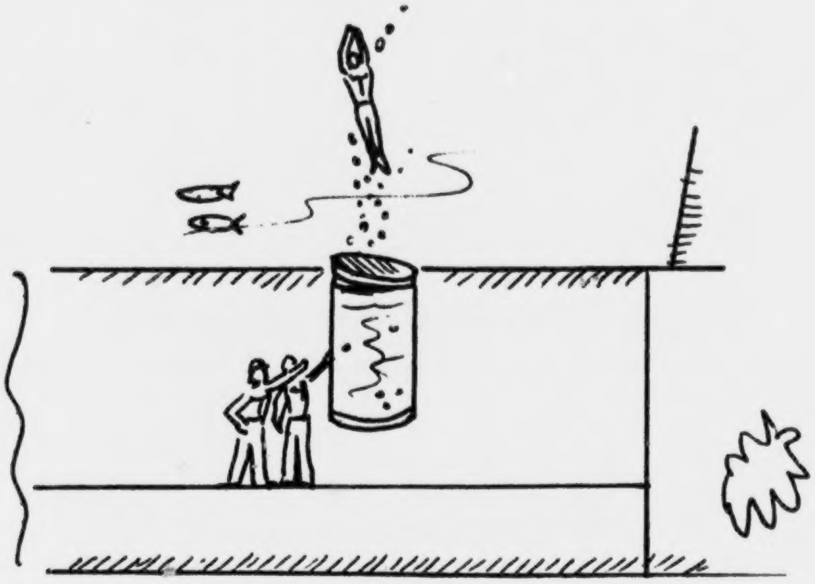
Instructions, Continued:

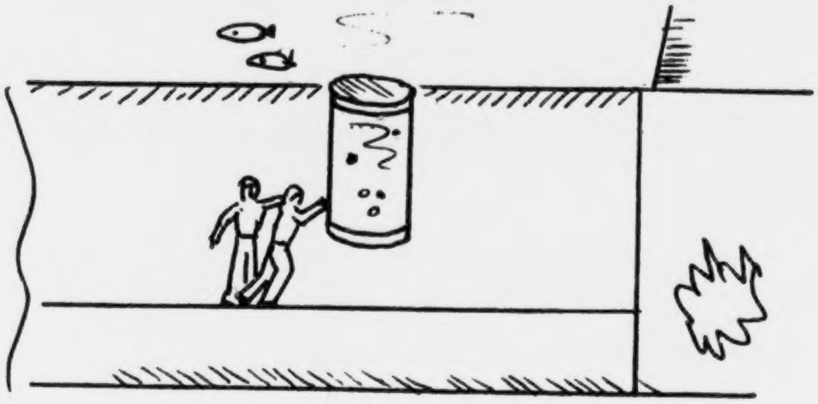
4. The submarine in the illustrations is lying at the bottom of the ocean. The crewmen are using the escape trunk for getting out and reaching the surface.

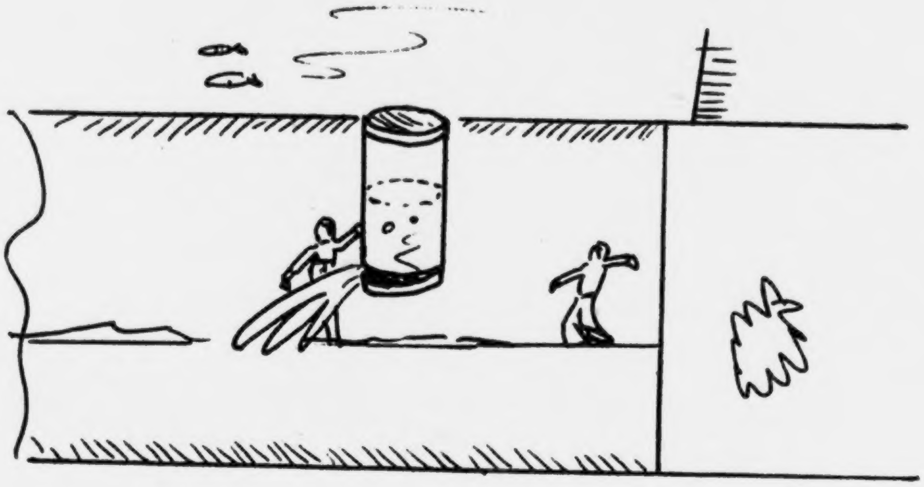
5. After you understand how the system works, write a composition and title it "How the Submarine Escape Trunk Works."

6. You may be called on to read your composition aloud.

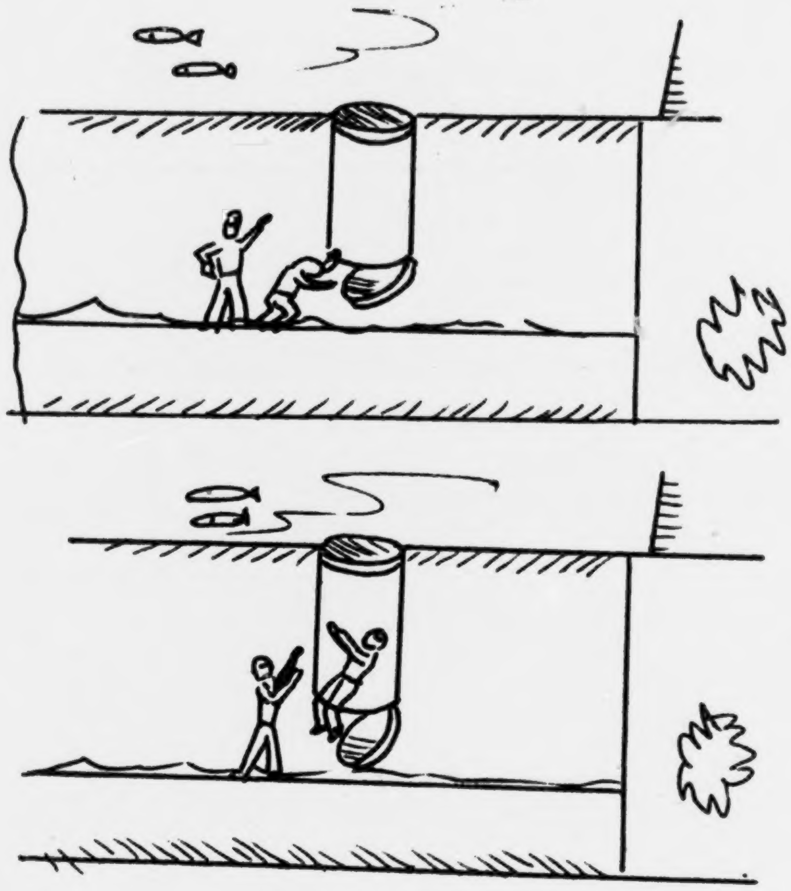
SUBMARINE ESCAPE
SHEET 3







SUBMARINE ESCAPE
SHEET 4



Unit 5

____
NAME

DEEP SUBMERGENCE RESCUE VEHICLE STUDY

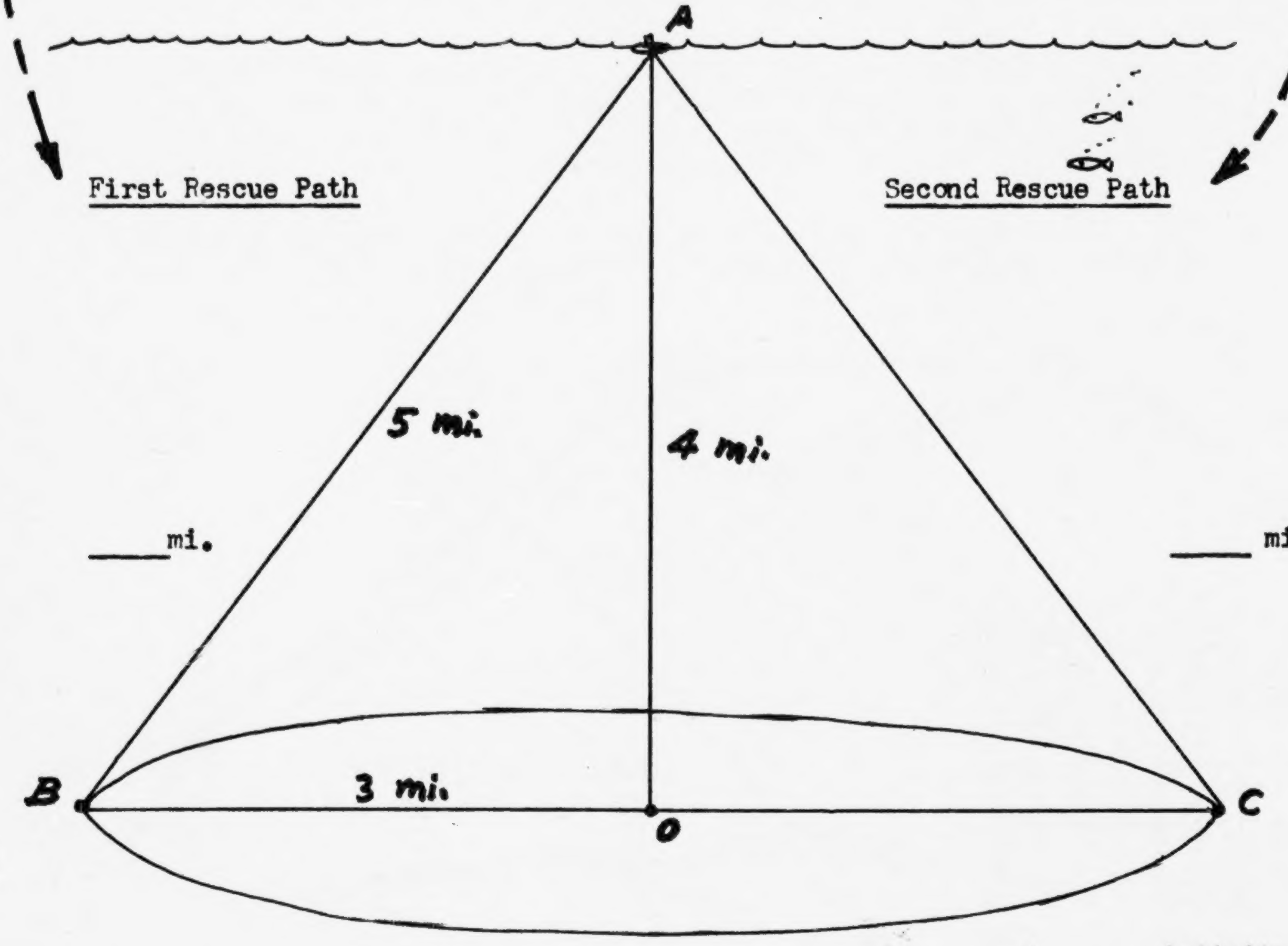
Instructions:

1. You are the Engineering Officer on board a Deep Submergence Rescue Vehicle.
2. Your job is to make sure the Rescue Vehicle is always ready to make emergency rescues.
3. You have been ordered to figure out two different kinds of rescue paths (see the figure below).

    * In the first rescue path, the Rescue Vehicle will:
    - a. Dive from point A to point O
    - b. It will then travel from point O to point B
    - c. It will then travel completely around the circle whose center is point O

    * In the second rescue path, the Rescue Vehicle will:
    - a. Dive from point A to point B
    - b. It will then travel completely around the circle whose center is point O

4. Calculate the distances for both paths. Do your work on this page.
5. Note: Circumference (distance around) of a circle equals 3.14 x diameter.



First Rescue Path

____ mi.

Second Rescue Path

____ mi.

SUBSUNK !

____
NAME

Instructions:

1. When a submarine has an accident, it sends out a SUBSUNK emergency message. If possible, a DSRV (Deep Submergence Rescue Vehicle) is rushed to the area.

2. Look at the Survival Curve below. The rescue mission is a race against time. The men in the sunken submarine have enough oxygen to last 24 hours. After that time, men start to pass out.

3. To save all the crew, the DSRV must reach the sunken submarine and deliver oxygen.

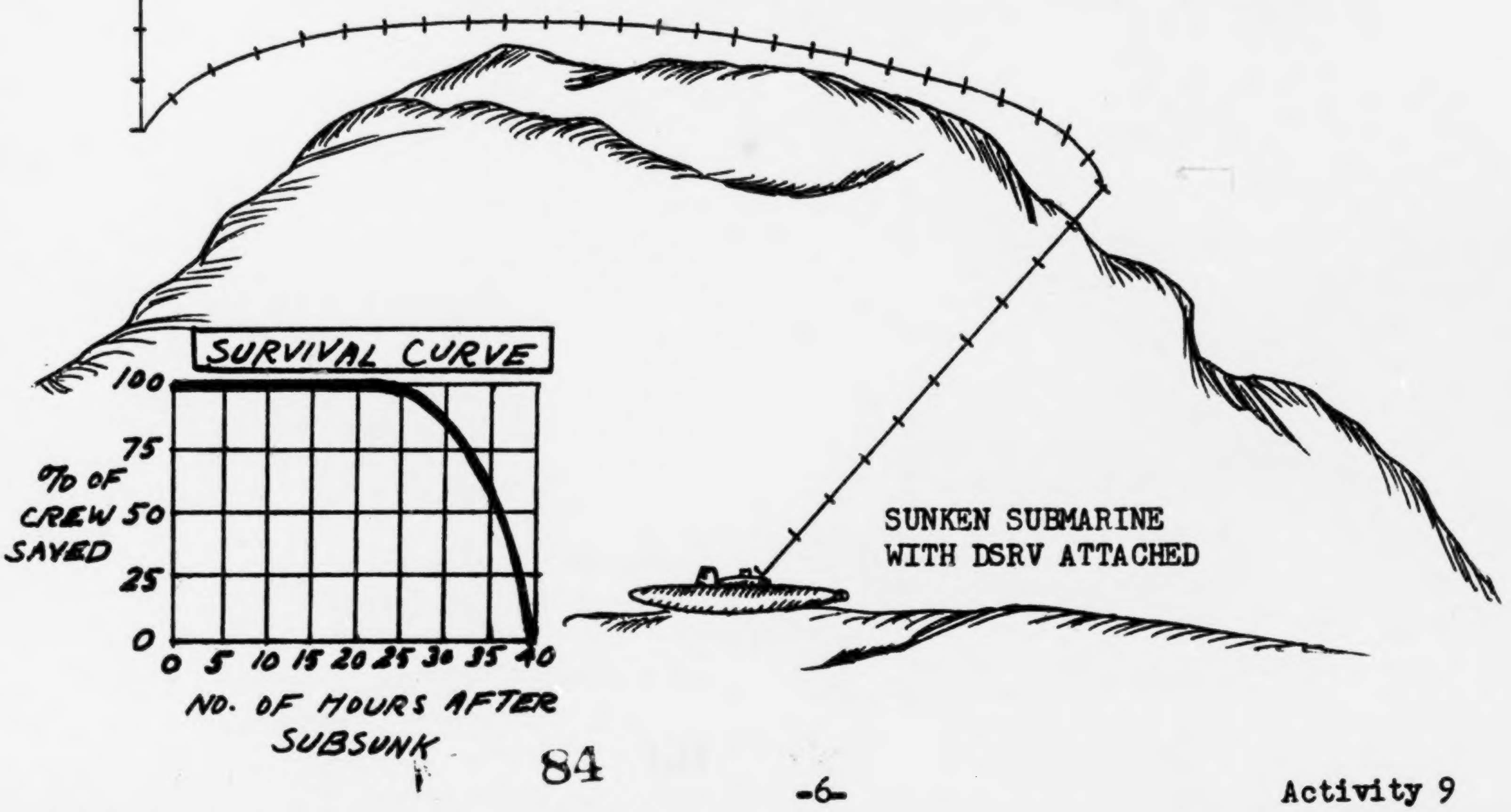
4. Suppose a submarine went down and sent a SUBSUNK message. 35 hours later a DSRV delivered oxygen. About what percentage of the crew would be saved ?

________ % (Answer)

---

5. Now work out the following problem. The submarine shown on this page sent out a SUBSUNK emergency message. 20 hours later the DSRV Mother Ship placed the DSRV in the water. The DSRV started on its rescue path shown by the lines (each division equals 4 minutes of travel time). What percentage of men was saved ? ________ %
(Answer)

6. HINT: Find number of minutes to reach sub. Change minutes to hours. Then find total number of hours to reach sub. SHOW YOUR WORK.



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Activity 1/2

I. YANKEM, D.D.S.
(DOCTOR OF DENTAL SURGERY)

SUMMARY

Following a brief explanation of the work performed by dental assistants, the teacher instructs the students in terminology and symbology used for marking dental records. Students complete a pair of self-tests and check their answers. The activity concludes with the students construction a pair of model teeth and marking them with symbols for tooth condition. They perform a "walkaround" inspection of the arrayed tooth models and mark dental records, simulating the work of dental assistant.

SOLO'S

1. The student can name the five surfaces of a tooth
2. The student can identify the dental symbols for:
    * Gold crown or gold filling
    * Pit cavity
    * Groove cavity
    * Missing tooth
    * Synthetic (plastic) filling
    * Amalgam (silver) filling

MATERIALS

1. One black (lead) pencil for each student
2. One red pencil for each student
3. Felt pen (for teacher)
4. About 2 inches of Scotch tape for each student
5. A pair of scissors for each student
6. A set of Activity 1/2 student materials for each student
7. One "Dental Record A" for half the students in the class; one "Dental Record B" for half the students in the class.

TEACHER'S GUIDE

1. This activity is designed to take two days. On the first day, the students are introduced into the background of work performed by dental assistants. The opening exericises are used to acquaint the student with terminology of tooth condition and identification of tooth surfaces. At the end of the first day's activity or on the second day, students construct "model teeth" from patterns supplied in their materials. Each student then marks his models to denote such conditions as cavity, filling, etc., employing the standard symbols. The teacher arrays the "model teeth" around a pattern (supplied as part of the teacher's materials) and writes numbers on the teeth. Students then walk around the arrays, inspecting the teeth and recording their findings on "Dental Records".
2. Start the activity by asking students to volunteer and talk about experiences they have had while visiting the dentist. Ask students to recall the kind of work that was performed by the dental assistant.
3. Tell the class that the shortage of professional doctors and dentists has caused these professionals to rely increasingly on the services of assistants. Point out that much of the doctor's or dentist's work requires the accurate collection of information that will enable him to do his job. The dental or medical assistant is often someone with special training (often, two years of junior college) who is very well paid and who does highly interesting work. Both men and women work in this profession.
4. Emphasize that the rapid rise of population in the United States coupled with the relatively small supply of doctors and dentists will require more reliance on "para-professionals," people whose training and experience will help to reduce the burden of work on the doctor and dentist.
5. Tell the class that this activity will introduce them to a typical job performed by a dental assistant: the recording of information on condition of a patient's teeth. Usually this job is performed by the dentist, with the the dental assistant standing by, recording it on a special form, called a "dental record". Point out that many dental assistants become as skillful as the dentist in their ability to identify tooth condition.
6. Hand out packets of student materials, and, referring to the illustrative materials, teach students the names of the sides of a tooth.

7. Tell students to look at their illustrations titled "Tooth Terminology". Tell them to observe that there are two basically different types of teeth in humans -the front teeth, used for biting and cutting, and the back teeth, used for grinding. Ask students to speculate on why there are two different types of teeth in humans but only one type (similar to molars) in certain other animals. Explain that humans are equipped to eat both meat (which requires one type of tooth action) and grains (which requires a different type of tooth action). Some animals are equipped with teeth that permit only one type of action.

8. Point out that the sides of the teeth are logically named. The facial sides face the face. The lingual sides face the tongue. Point to the imaginary mid-line running down the center of the mouth. Point out that the mesial sides face this line; the distal sides face away from it. The occlusal sides are those that grind. Point out the the rear teeth have occlusal sides, but the front teeth do not.

9. Tell the students to turn to the "Teeny Tooth Test". Tell them to fill in the answers at the bottom of the figure. Go over the correct answers when they have finished the test.

10. Instruct students in the terminology and symbols for desribing the condition of teeth. Refer them to the illustration titled "Condition of Teeth Shown by Symbols". Point out that the condition is shown on the tooth as a picture. Alongside each picture is a symbol used by the dentist and dental assistant to record the condition. Point out that pit and groove cavity symbols are drawn in red pencil.

11. Hand out Dental Record A's and Dental Record B's, alternating them among students to discourage copying. Tell the class to read the instructions at the top and do the examination on their own.

12. When students have finished, go over the correct answers.

13. At this point, the class is ready for the second part of the activity. The teacher may wish to prepare one or two tables after referring to the illustration titled "How to Use the Table-Top Tooth Guide". With the tables prepared, the teacher will be ready to locate the finished "model teeth".

14. Refer students to the illustration titled "Dental Record". Tell them that this is a copy of the form used in dentists' offices to record conditions of the patients' teeth. Tell them to observe how the dental record is an "unfolded" picture of the tooth, showing all its sides.

15. Tell the class to cut out and assemble the two teeth on the page titled "Models of Teeth". Supply tape for holding the folded surfaces in place. Preferably, allow students to figure out how to assemble the model teeth on their own, or by helping one another. Also, hand out red pencils.

16. Tell the students to mark one condition on each tooth. Write the conditions on the chalkboard:

    * Pit cavity (red)
    * Groove cavity (red)
    * Synthetic (plastic) filling
    * Amalgam (silver) filling
    * Gold crown or gold filling

    Emphasize that they are to use the symbol for each of the conditions, not pictures of the condition.

17. As students complete their models, have them bring them to the tables for positioning around the figure titled "Table-Top Tooth Guide". It is not important that the arrayed "teeth" duplicate exactly their positions in the mouth. Place the teeth in their relative positions, with molars in the rear and canine-type teeth in front. The number of teeth arrayed around the table is not important. Although the human mouth has 16 upper and 16 lower teeth it is perfectly acceptable for the purposes of this exercise to have, say, 10 or 20, or even more, in a single array.

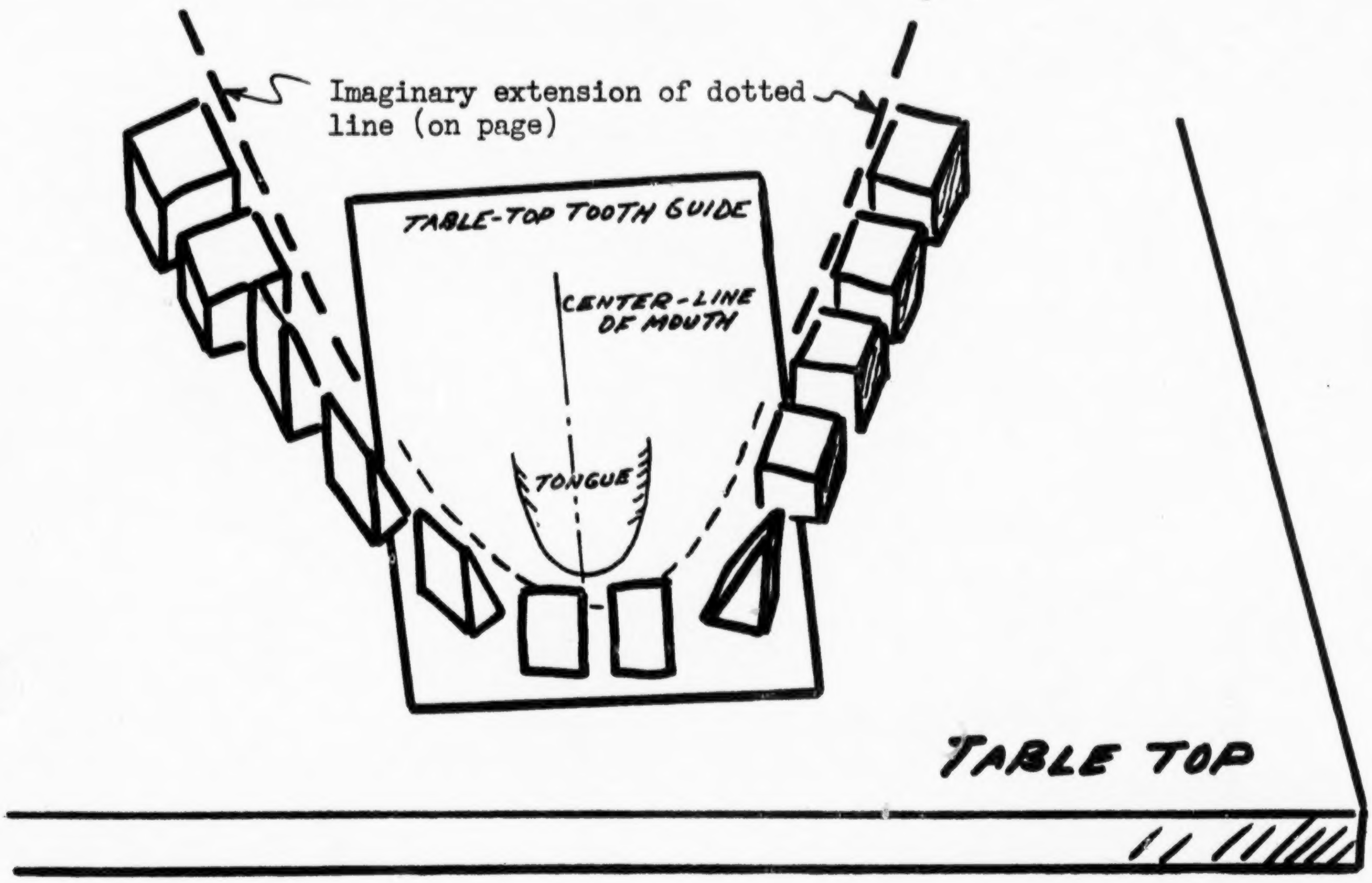
18. When all the teeth for a single array are handed in, write numbers on them, using a felt pen. Be careful not to obscure the students' symbols. Timing will dictate how many arrays there will be. A total number of 36 teeth (in one or two arrays) is acceptable.

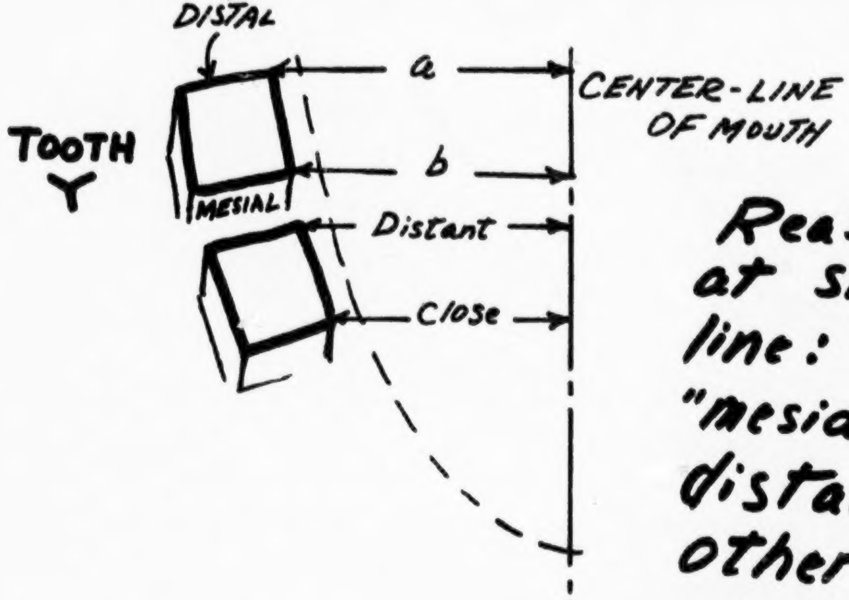
19. When all the model teeth have been arrayed, tell students to take their "Dental Records" and walk around the arrays, marking the condition and side of each tooth in the array.

20. When all students have completed their "walkaround," conclude the activity by scoring the sheets and identifying the best male and female dental assistants and "runners-up".

HOW TO USE THE TABLE-TOP TOOTH GUIDE

1. Place Table-Top Tooth Guide on flat surface.
2. Arrange "teeth" outside of dotted line (and its imaginary extension) as shown.
3. Make certain that "teeth" are slanted away from center-line for reason explained below.



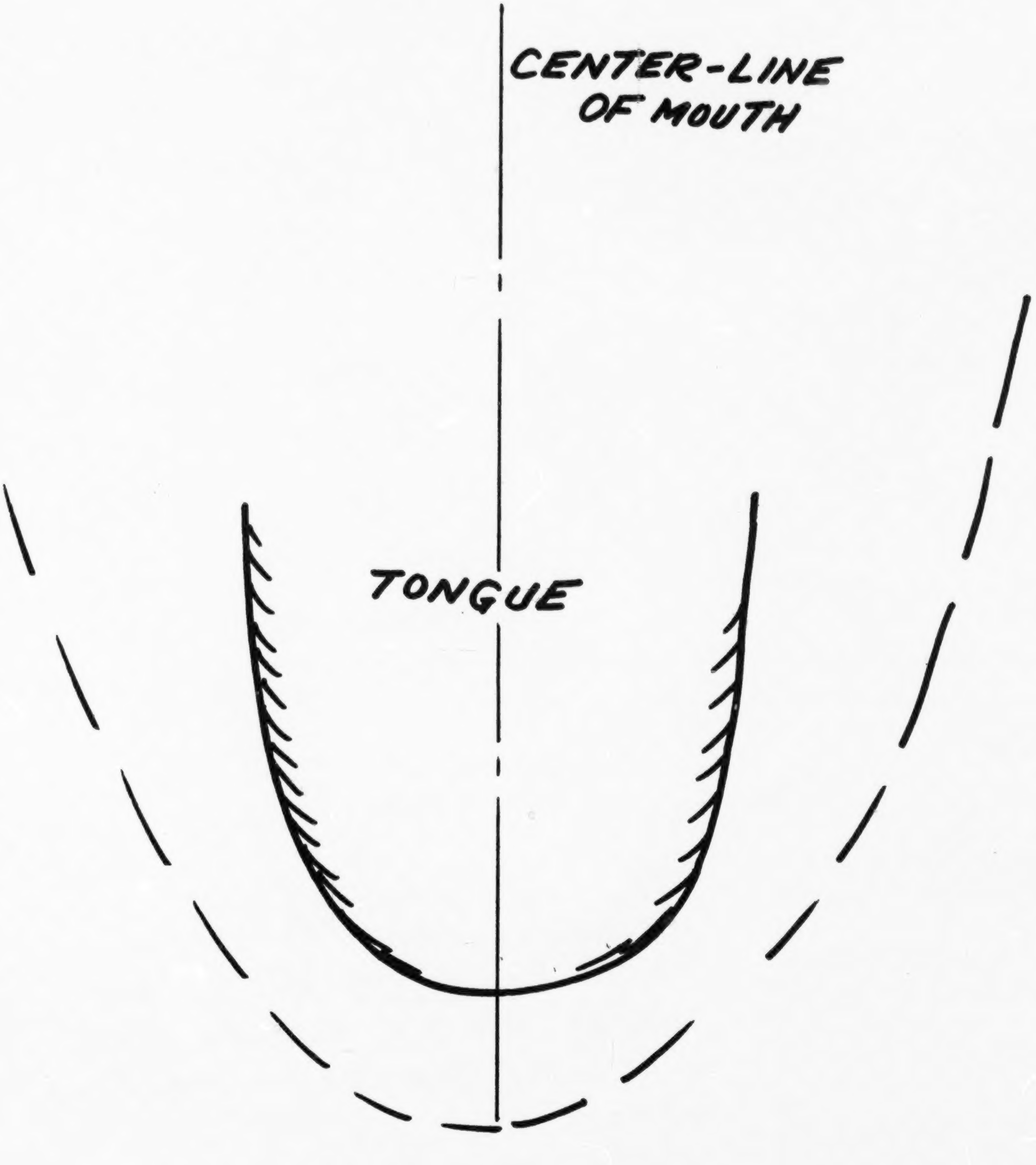


DISTAL SIDE FACES AWAY FROM MID-LINE

Reason for placing Teeth at slight angle to Center-line: To *define* "distal" and "mesial," one side must be more distant (from center-line) than other-

Notice that Tooth Y is drawn with mesial side closer to Center-line (distance b).

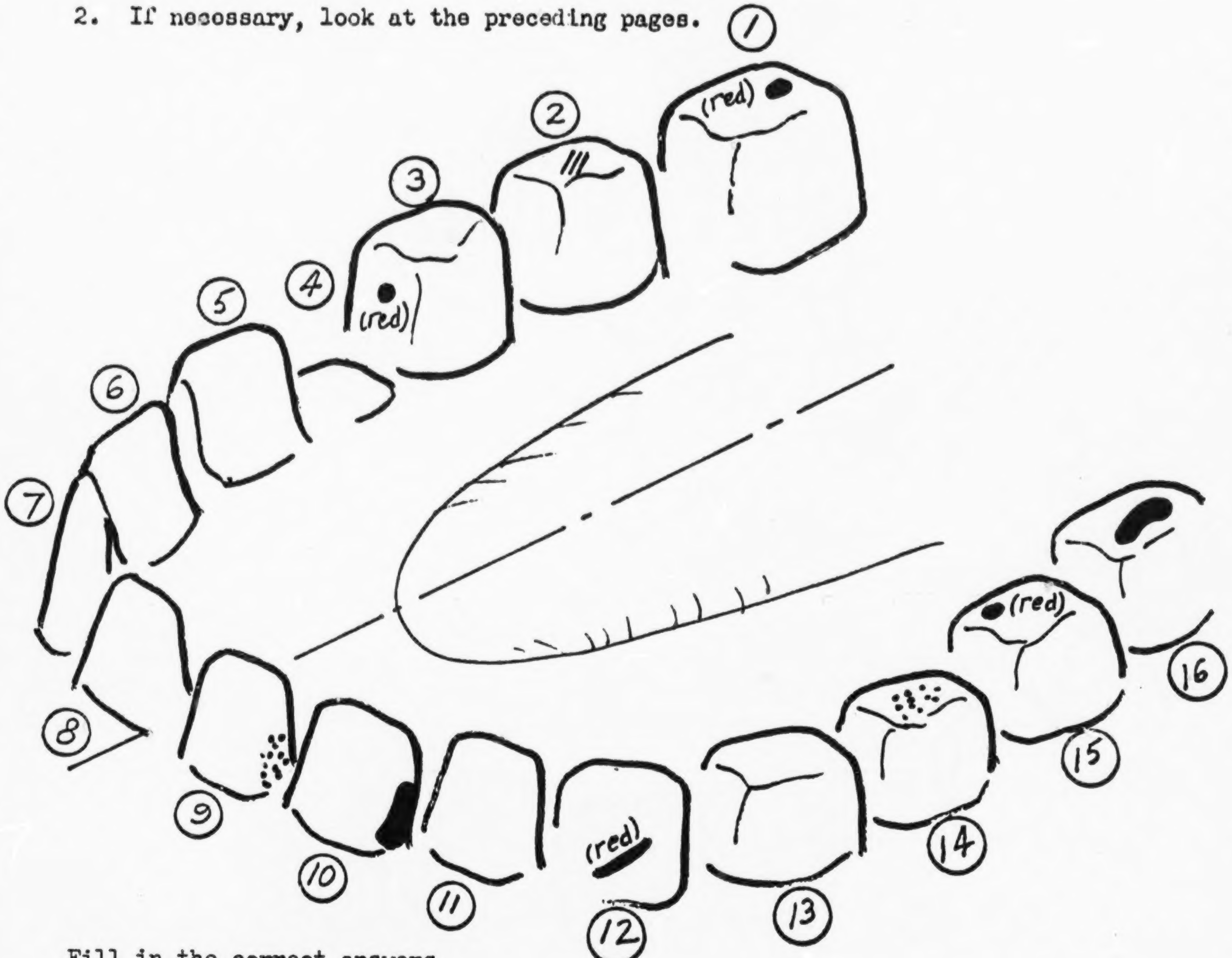
TABLE-TOP TOOTH GUIDE



DENTAL RECORD A
(Teacher's Key)

Instructions:

1. Complete the exercise at the bottom of this page.
2. If necessary, look at the preceding pages.



Fill in the correct answers

a. Which tooth has a gold crown ? 2

b. Which tooth has a groove cavity ? 12

c. Which tooth has a synthetic (plastic) filling on its occlusal side ? 14

d. Which tooth has a pit cavity on its mesial side ? 3

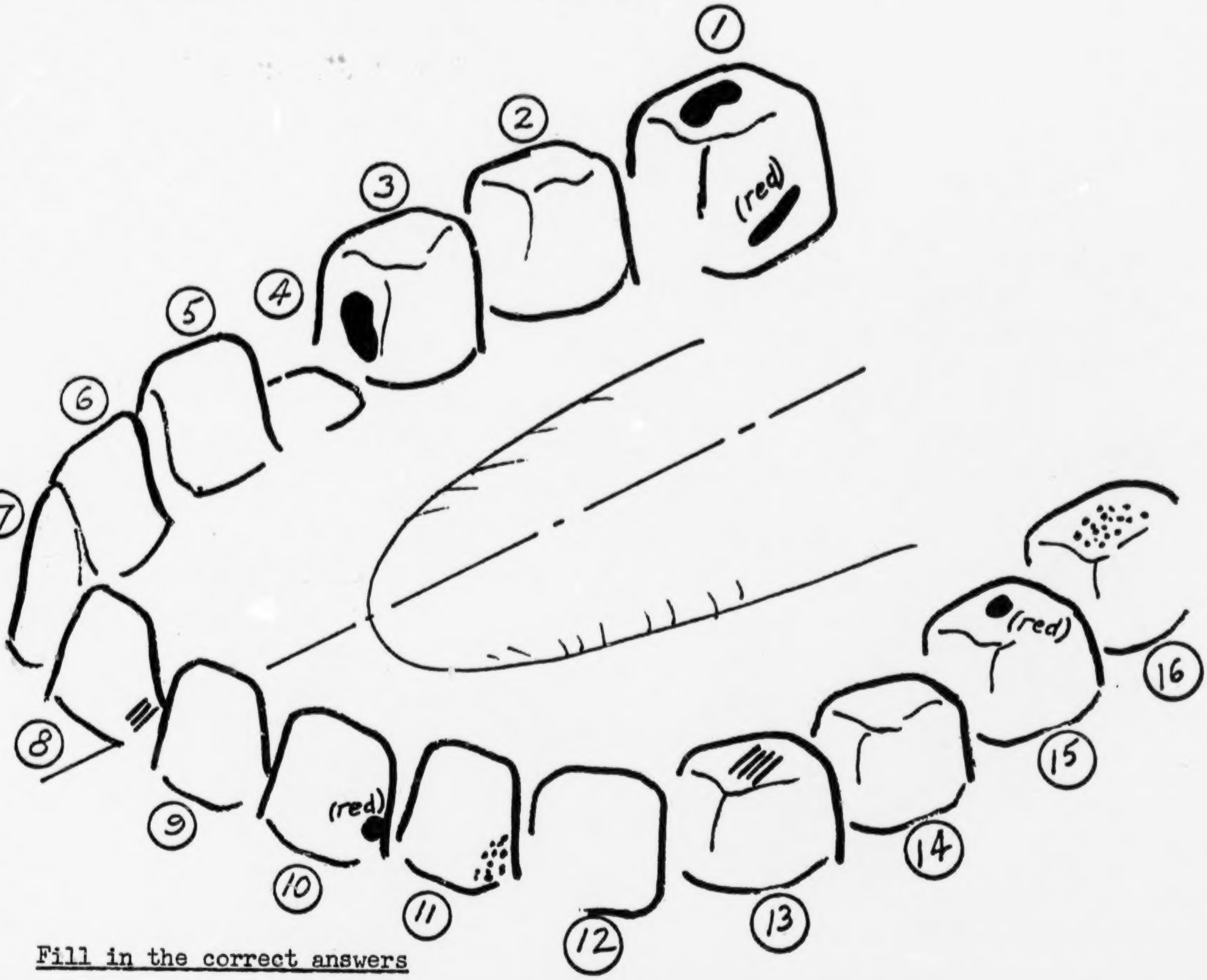
e. What does this symbol mean: X missing tooth

f. Which tooth has an amalgam filling on its distal side ? 10

DENTAL RECORD B
(Teacher's Key)

Instructions:

1. Complete the exercise at the bottom of this page.
2. If necessary, look at the preceding pages.



Fill in the correct answers

a. Which tooth has a synthetic (plastic) filling on its distal side ? 11

b. Which tooth has a gold crown on its occlusal side ? 13

c. What symbol stands for (tooth) number 4 ? X

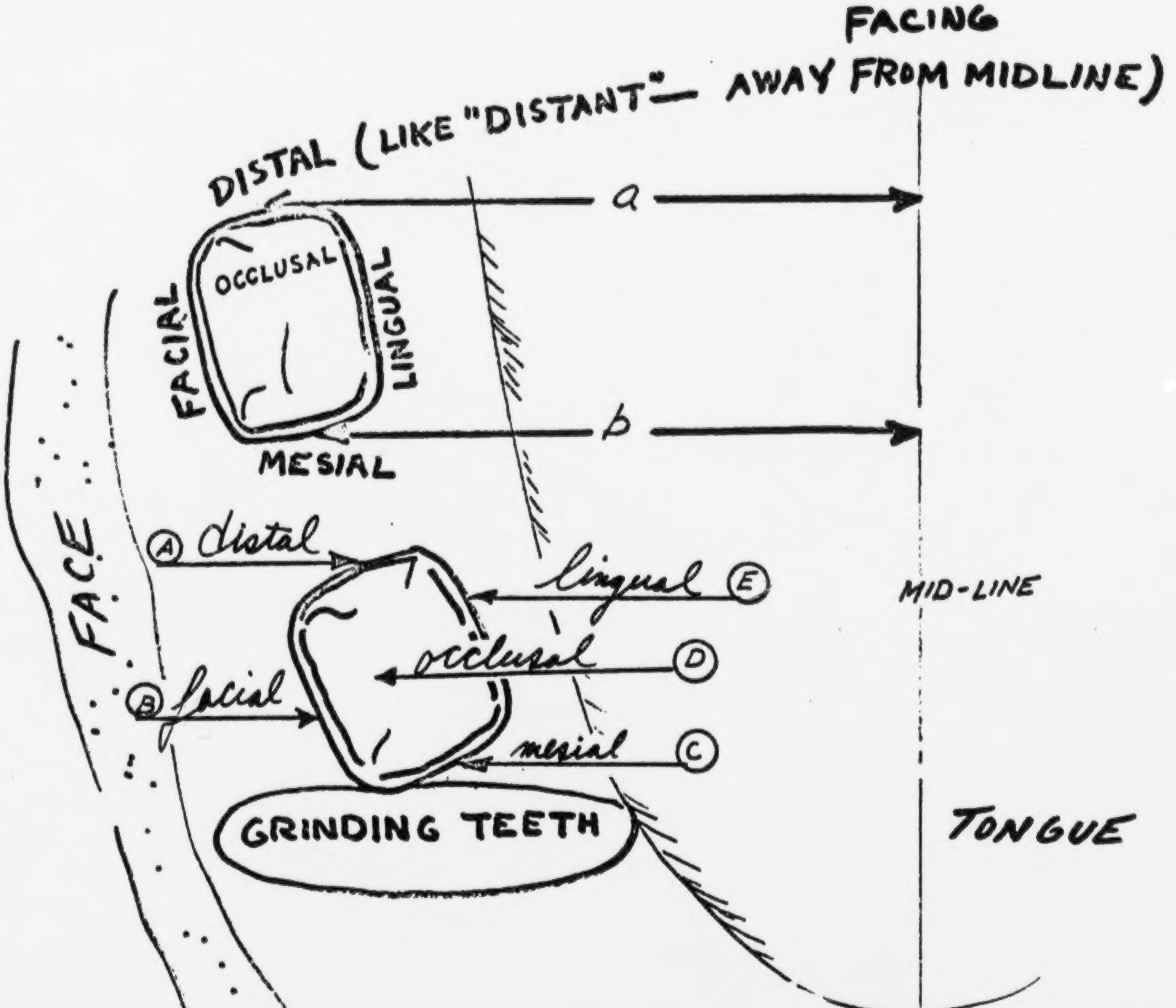
d. Which tooth has an amalgam filling on its mesial side ? 3

e. Which tooth has a groove cavity ? 1

f. Which tooth has a pit cavity on its distal side ? 10

TEACHER'S ANSWERS

TEENY TOOTH TEST



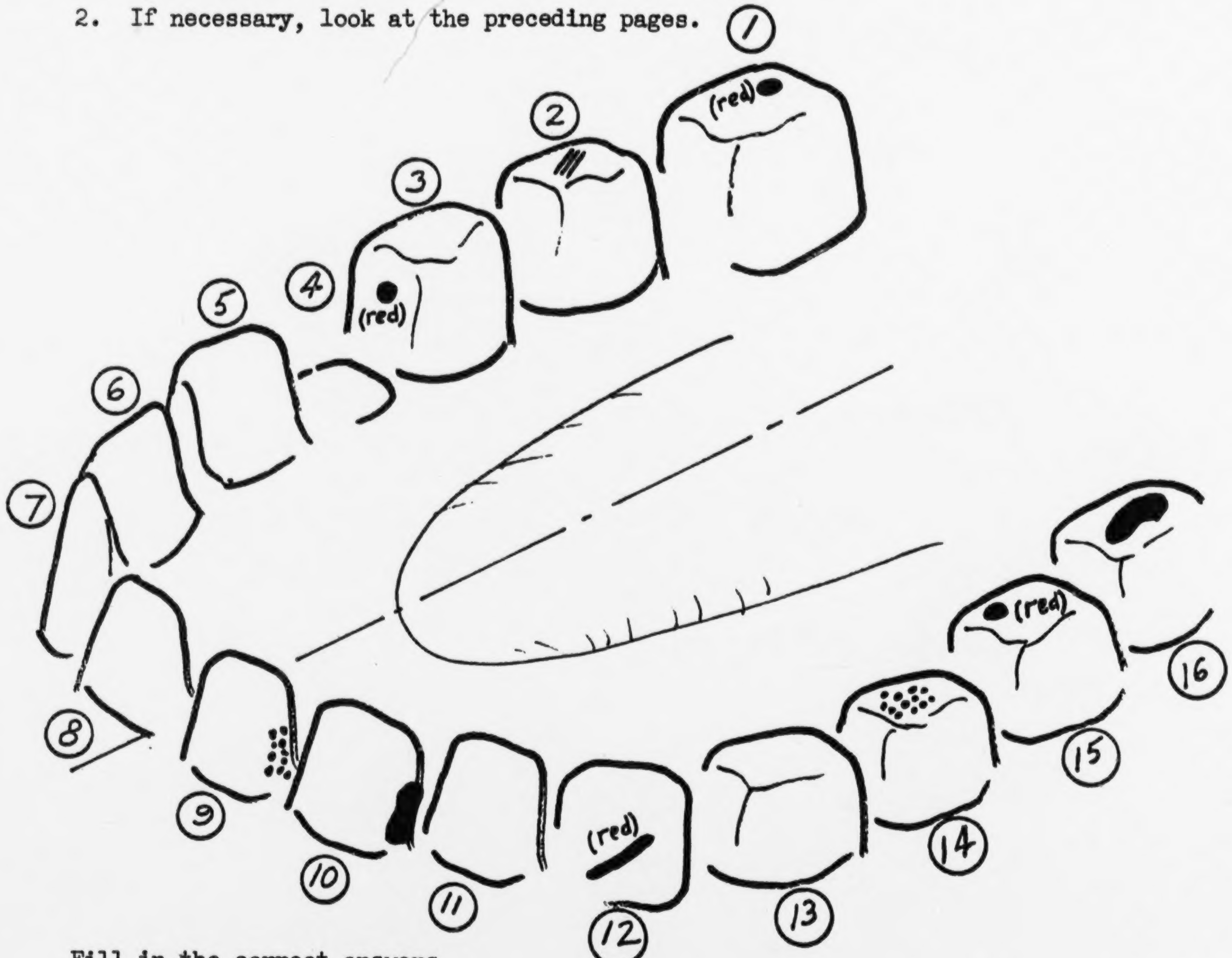
A TOOTH HAS 5 SIDES

- LINGUAL
- FACIAL
- MESIAL
- DISTAL
- OCCLUSAL (CUTTING TEETH DO NOT HAVE THIS SIDE)

DENTAL RECORD A
(Hand-out)

Instructions:

1. Complete the exercise at the bottom of this page.
2. If necessary, look at the preceding pages.



Fill in the correct answers

a. Which tooth has a gold crown ? ____

b. Which tooth has a groove cavity ? ____

c. Which tooth has a synthetic (plastic) filling on its occlusal side ? ______

d. Which tooth has a pit cavity on its mesial side ? ______

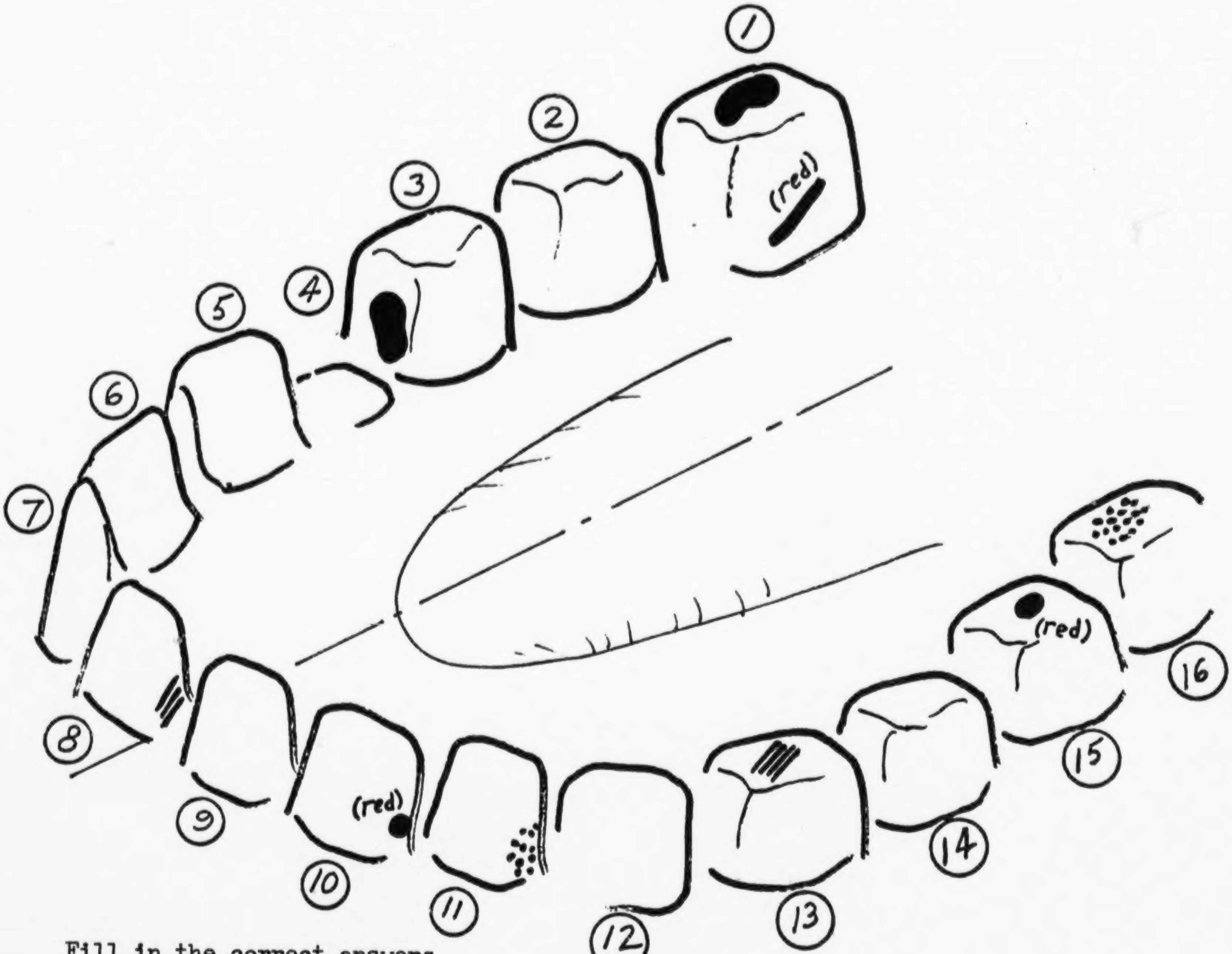
e. What does this symbol mean: X ________________

f. Which tooth has an amalgam filling on its distal side ? ____

DENTAL RECORD B
(Hand-out)

Instructions:

1. Complete the exercise at the bottom of this page.
2. If necessary, look at the preceding pages.



Fill in the correct answers

a. Which tooth has a synthetic (plastic) filling on its distal side ? ______

b. Which tooth has a gold crown on its occlusal side ? ____

c. What symbol stands for (tooth) number 4 ? ______

d. Which tooth has an amalgam filling on its mesial side ? ___

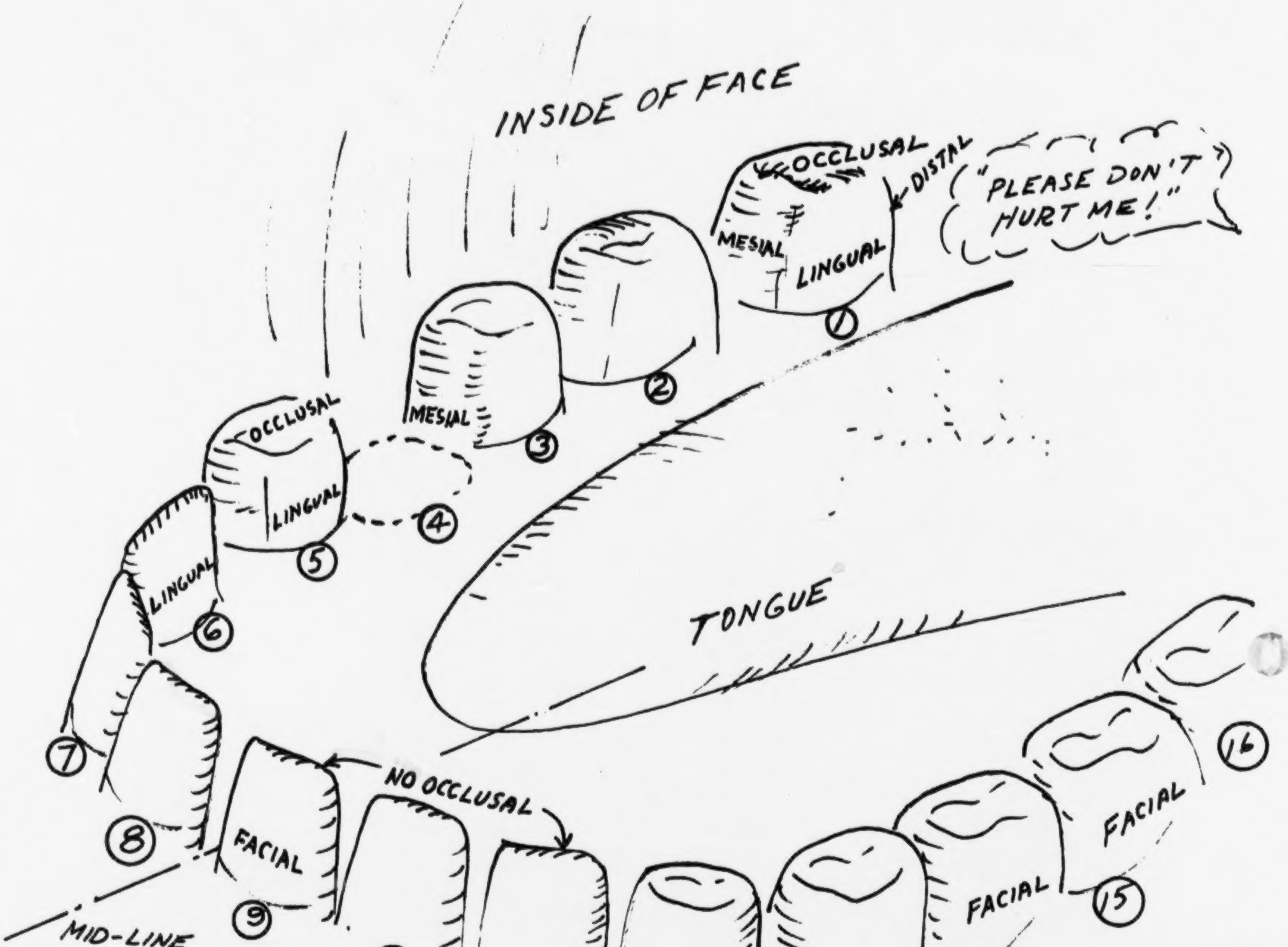
e. Which tooth has a groove cavity ? ____

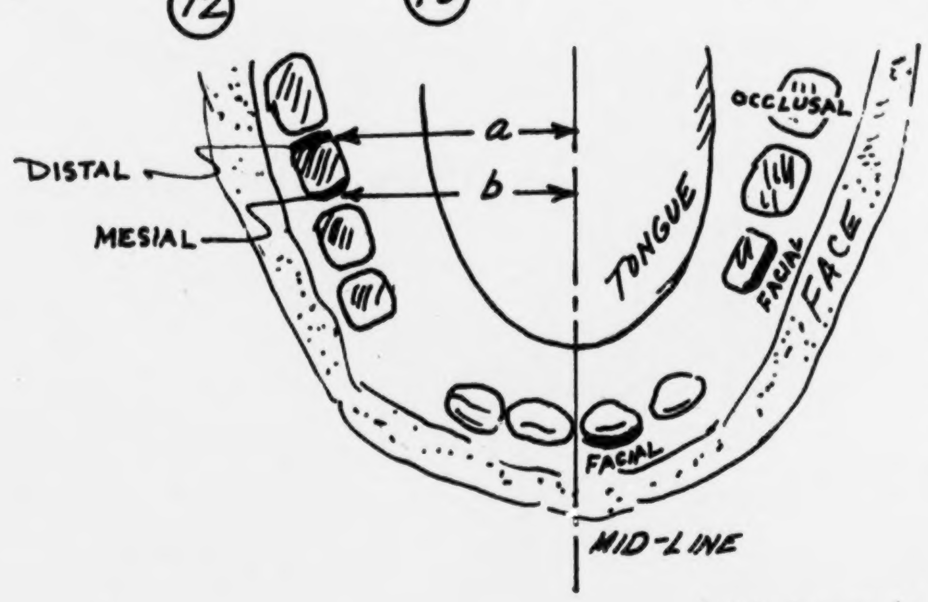
f. Which tooth has a pit cavity on its distal side ? ___

Activity 1/2

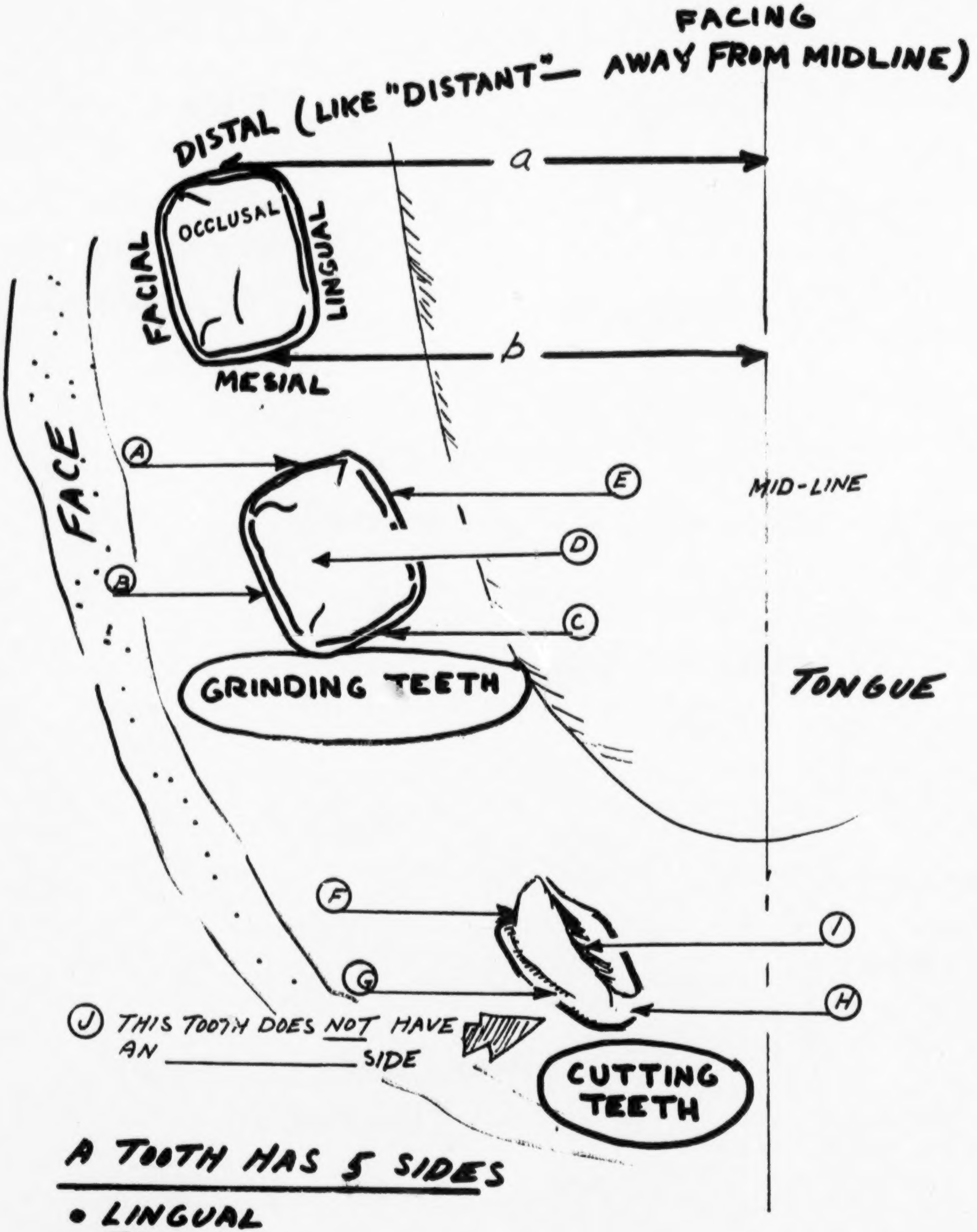
The Office of Dr. I. Yankem

TOOTH TERMINOLOGY





TEENY TOOTH TEST

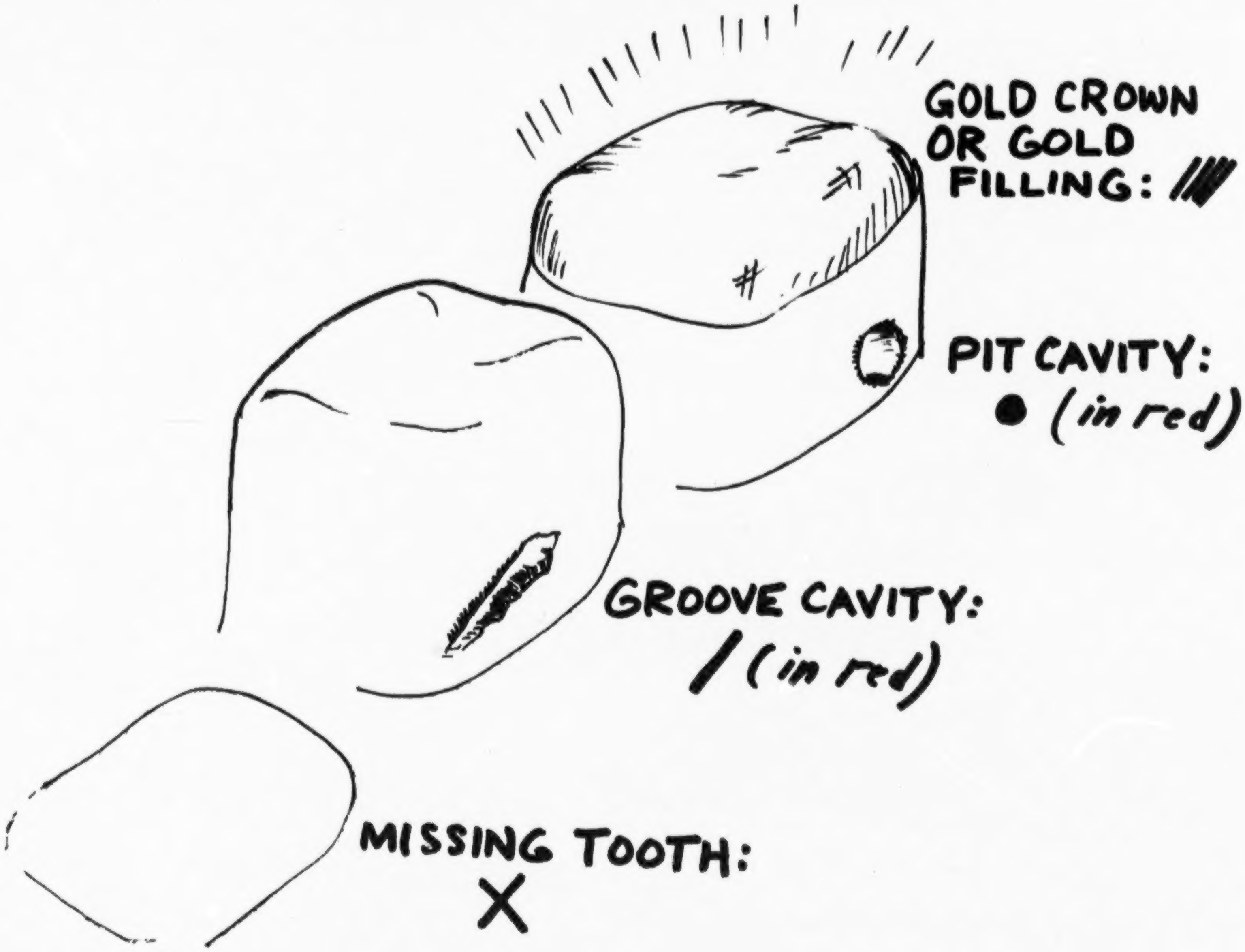


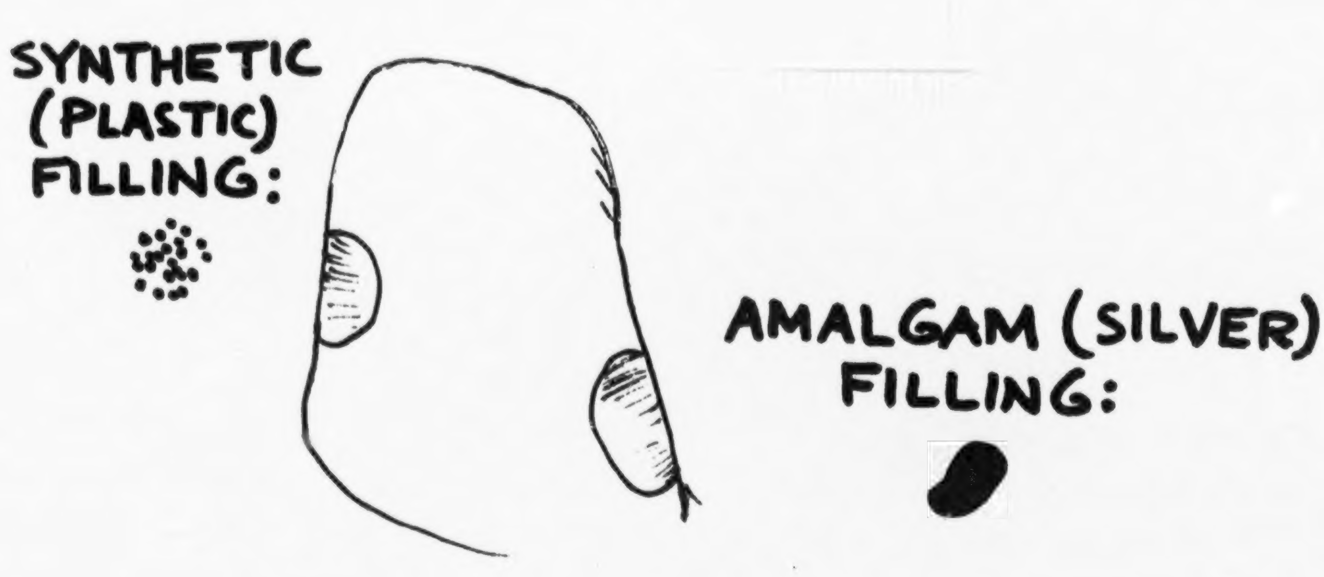
Ⓙ THIS TOOTH DOES NOT HAVE AN ________ SIDE

A TOOTH HAS 5 SIDES

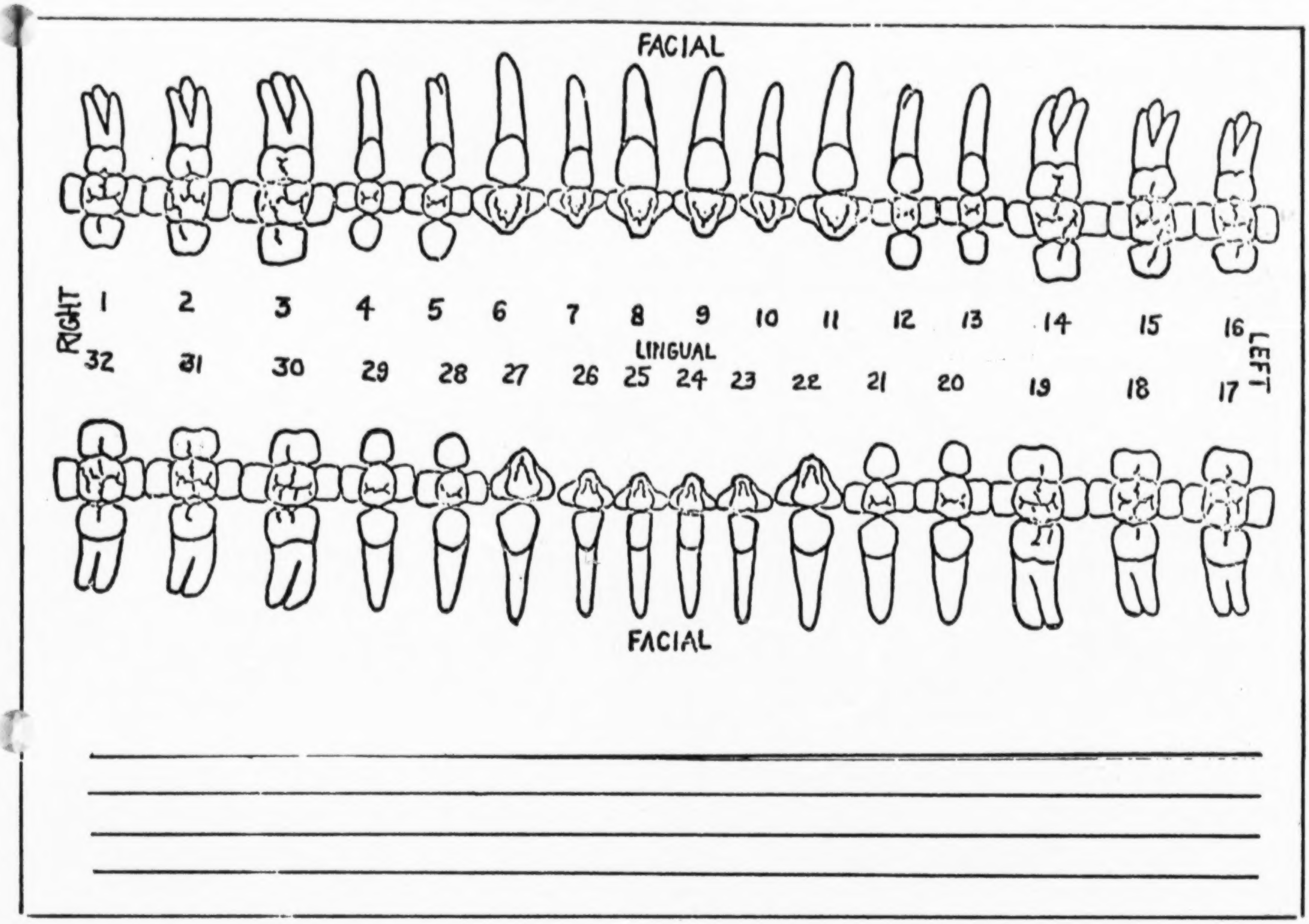
- LINGUAL
- FACIAL
- MESIAL
- DISTAL
- OCCLUSAL (CUTTING TEETH DO NOT HAVE THIS SIDE)

CONDITION OF TEETH SHOWN BY SYMBOLS



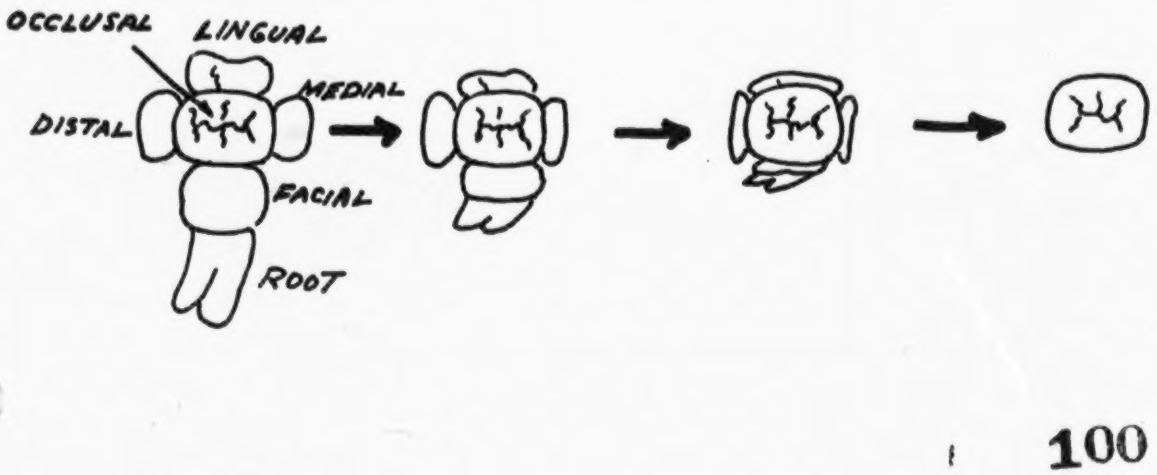


DENTAL RECORD



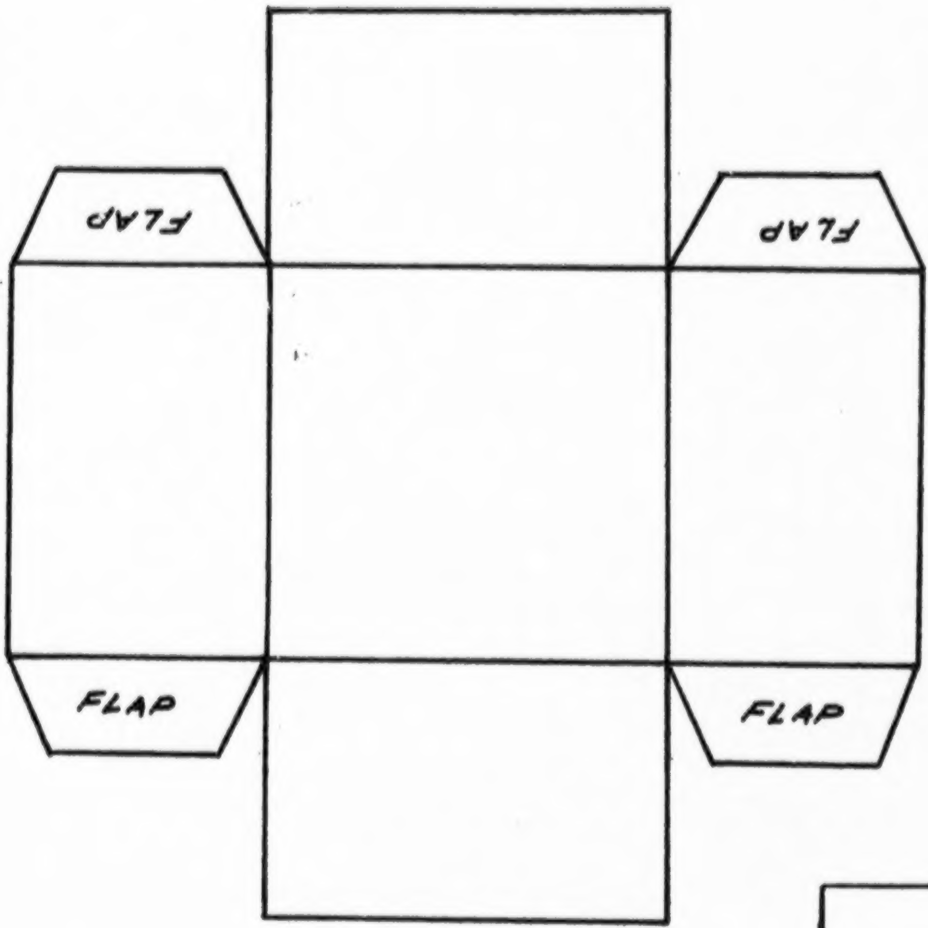
This Dental Record is used by the dentist and dental assistant to show the condition of teeth. A black pencil and a red pencil are used.

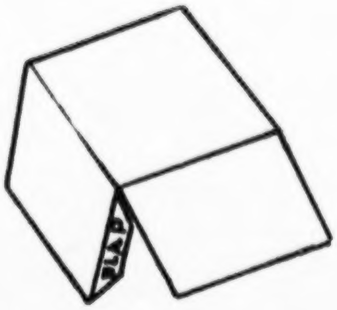
Notice how the diagram of each tooth allows all sides to be marked.



MODELS OF TEETH

MOLAR

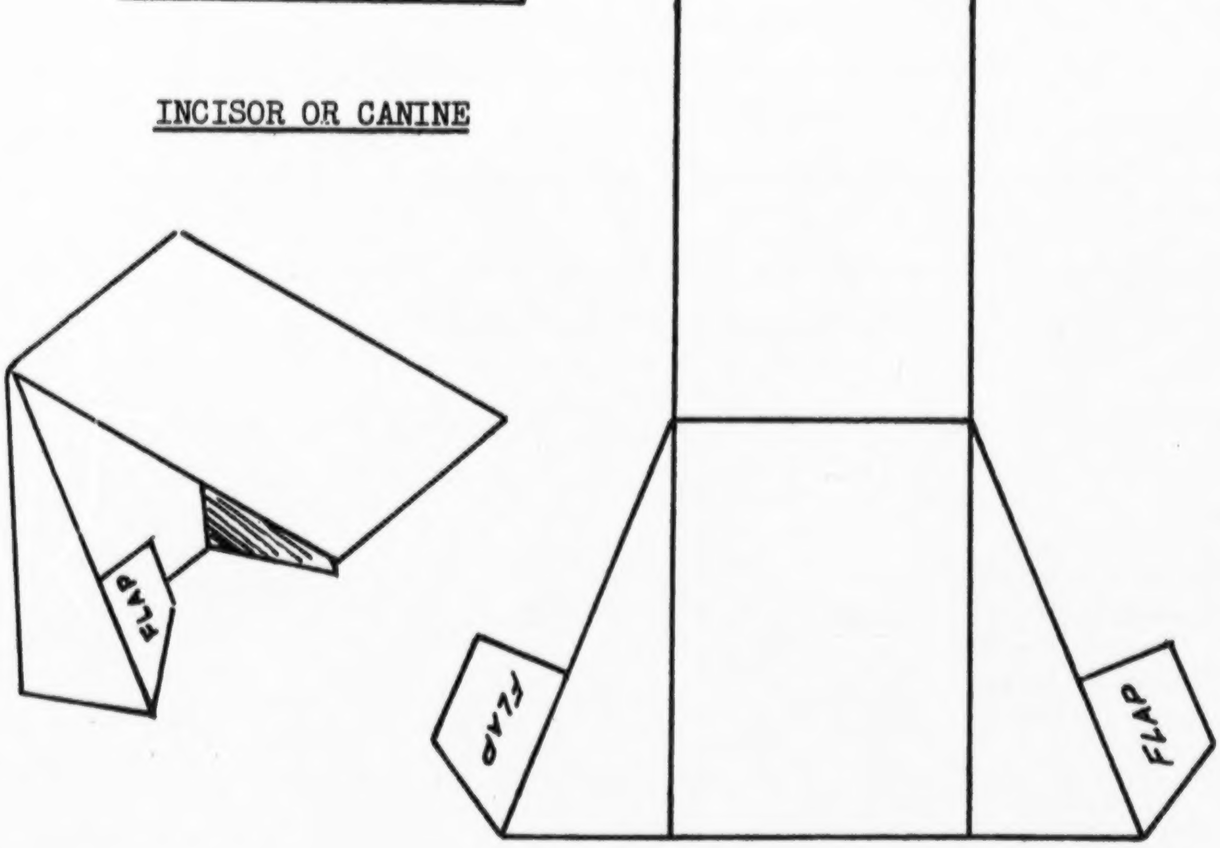




Note: When you assemble these teeth, place the scotch tape on the inside.

Do not place any tape on the outer surface of the teeth.

INCISOR OR CANINE



DENTAL RECORD

(Name of person performing exam.)

Instructions:

1. You are a Dental Assistant. You will perform a dental examination.
2. Walk around the table-top exhibition of model teeth.
3. Write down the tooth number, condition, and side (on which you found the condition) of each tooth.

Tooth No.	Condition	Side	Tooth No.	Condition	Side
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
10			28		
11			29		
12			30		
13			31		
14			32		
16			33		
17			34		
18			35		
			36		

Activity 9

LOAN OFFICER'S SIMULATION

Original idea and preliminary design by J. Bishop and K. Caporale, Woodrow Wilson Jr. H.S.

SUMMARY

Following an introduction into the ideas of credit buying with a teacher-led discussion, students are given Loan Officer's Worksheets and Loan Applicants' data sheets. In this simulation, each student plays the role of a Loan Officer in a loan company which has received a number of applications for loans. Working from the applicants' data sheets and the Loan Officer's Worksheets, the student sums the applicant's monthly expenses and transfers this information onto a step-by-step process worksheet which leads him to the point where he can determine whether or not the applicant qualifies for a loan. In carrying out this process, the student follows written instructions and employs addition, subtraction, multiplication, and long division.

SOLO'S

1. The student can follow the printed instructions of the Loan Officer's Simulation
2. The student can write a short composition (approximately 25 words) describing the manner in which the Loan Officer (in the Loan Officer's Simulation) decides whether or not an applicant should be granted a loan.

MATERIALS

1. Pencils
2. Four Loan Officer's Worksheets for each student (each worksheet consists of a pair of stapled pages)
3. One Loan Applicants' data sheet for each student (each data sheet is divided into four sections; students receive one of the four sections at a time)
4. Scissors or paper slicer (for teacher) to separate four sections of Loan Applicants' data sheets

TEACHER'S GUIDE

1. Prepare the class for this activity by spending a few minutes talking about credit buying. Ask such questions as these:

    - * Should a person borrow money to buy something ?
    - * How does a person decide whether or not he should borrow money to buy something ?
    - * If a person decides to borrow money, how should he decide to go about borrowing it ?
    - * Do loan companies serve an important need ?
    - * Why do loan companies charge interest on money to borrowers ? (Explain the term "interest.")
    - * Should someone who is loaning money be allowed to charge as much interest as he wishes for the money ?
    - * Should loan companies lend money to anyone who comes to them ?
    - * If you owned a loan company or worked for one, what would you want to know about the person who applied for a loan ?
    - * Do you think a person's privacy is invaded by loan companies that ask many personal questions ?

2. Building upon the discussion promoted by the preceding questions, point out that loan companies are businesses, like many others. They sell finance, and in doing so they attempt to make a profit in competition with other companies.

    Point out that loan companies are regulated in the way they do business. Until recently, people often took out loans without understanding how much they were paying for them. Laws were passed that require the loan company to state in writing the exact terms of the loan. This protects the borrower at the time he takes out the loan.

3. Point out that loan companies, since they are in business to make a profit, must be very careful in the way they loan out their money. If they loan money to someone who is not responsible, they stand to lose the money they are lending. Loan companies therefore investigate the loan applicant's background very carefully.

4. Ask the class to name some of the things a loan company would want to know about a loan applicant's background. Encourage the students to think in such

practical terms as: Does the applicant have a job ? How much does the applicant earn as compared to how much does he wish to borrow ? (Obviously, the loan company will not loan a million dollars to someone who is earning eighty dollars a week; however, it might lend a million dollars to the owner of a company that does a half million dollars worth of business a year.)

Other typical, practical questions are: What are the loan applicant's spending habits ? Is he living too high? Emphasize that the loan company requires assurance that the money will not only be paid back, but that the interest (which includes the company's profit) will be paid back as well.

5. Tell the class that in this simulation they will play the role of Loan Officer for a loan company. The job of the Loan Officer is to (among other things) look into the loan applicant's money needs and compare them with his income. The Loan Officer calculates how much the loan will cost to the applicant and decides whether or not the applicant should be granted the loan. To do so, the Loan Officer must apply arithmetic and reading skills.

6. Hand out a Loan Officer's Worksheet (two pages stapled together) to each student. Tell the class to examine the worksheet. After the students have spent a few minutes looking over the worksheet, tell them that they will be given Loan Applicants' data sheets to work with.

7. Tell the class that they will use the information on the Loan Applicants' data sheets to calculate whether or not the applicant should be given a loan. Point out that the decision is based on the loan company's policy. The policy can be stated as follows:

   - The loan company is in business to earn a profit.
   - The company will lend money only to those people it believes are in a good position to pay the money back.
   - The loan company will charge the applicant interest and a service charge.

   The teacher may wish to spend a minute or so defining "interest." Most students should be aware that banks pay depositors interest. But they may not know why. It should suffice to tell the students that cash has earning power. If a bank pays its depositors 5% (5 dollars on every 100 dollars deposited for a year), we can be sure that the bank is earning more than 5% on the depositor's money that is being loaned to other people.

This hold true with loan companies as well. The loan company fixes its interest rates in a way that assures there will be a higher return than if the loan company simply placed its money in a bank, and earned interest in that way.

8. Point out that interest rates on loans can be quite high. But also point out that some people are perfectly willing to pay the interest rates if they can gain the use of something immediately. Mention that when someone "buys" a house, it is practically unheard of for payment to be made in cash for, say, a $25,000 house. Instead, the home "buyer" takes out a loan (mortgage) from a lending agency, usually a bank, and proceeds to pay off the loan over a period of many years (up to 30). Point out to the class that when someone buys a house, he may end up after 30 years paying $50,000 for a $25,000 house. But point out that people are still willing to do this because:

    * They don't have the $25,000 in cash to buy the house in the first place
    * They have the immediate use of the house after they qualify for the loan and move in
    * The monthly loan payments are usually reasonable. They are within the ability of the home buyer to pay them without straining his budget.

9. Returning to the Loan Officer's simulation, tell the students to follow the directions on their Loan Officer's worksheets, using the information on the Loan Applicants' data sheets. Distribute the Loan Applicants' sheets.

    Note: Each Loan Applicants' data sheet contains four rectangles of data. The teacher should separate these with a pair of scissors or paper cutter, and be be prepared to distribute the parts (one at a time) to the students. The reason for this is to assure individual work. One student may be given the portion titled "L. Owans - Cashier"; the adjacent students may be given portions titled "C. Rado - Secretary" and "K. Royal - Office Manager." This should discourage copying, etc.

10. Go through the method of completing a "Loan Officer's Worksheet." Begin by telling the class they must first complete the sum on the Loan Applicants' data sheet. Then they must transfer information onto the Loan Officer's Worksheet. In going through the steps, do not use actual

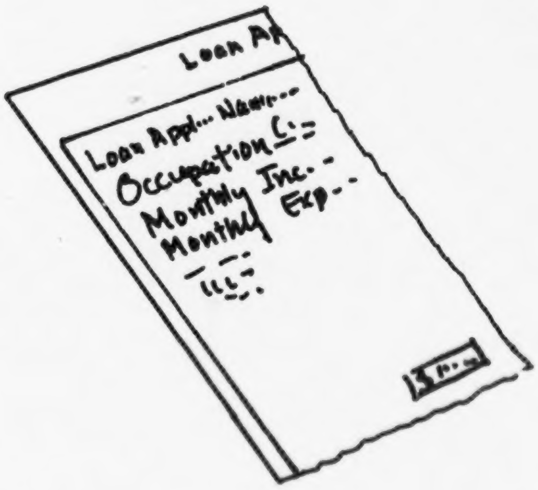
numbers. Instead, concentrate on what must be done in each step along the way. After you have gone through a "dry run," tell the class they are on their own.

11. Circulate among the students offering assistance where it is needed on an individual basis. Encourage students to work out their loan applications independently.

12. As students complete the individual loan applications, check them for accuracy. When a student completes an application correctly, give him another Loan Applicants' data sheet. (USE THE CHECKLIST PROVIDED.)

13. After most of the students have completed two or three Loan Officer's Worksheets, collect all materials. In the time remaining, have the students write a short description of how the Loan Officer decided whether or not an applicant should be granted a loan. Tell the class to limit compositions to about 25 words.

MATERIALS FOR LOAN OFFICER'S SIMULATION


Loan Ap
Loan Appl... Name...
Occupation
Monthly Inc.
Monthly Exp.
$

Portion of Loan Applicants' data sheet

Loan Officer's Worksheet

LOAN APPLICANTS' DATA
(Teacher's Key)

Loan Applicant's Name L. Owens
Occupation Cashier
Monthly Income $ 320
Monthly Expenses

Rent	$ 80
Food	40
Utilities	5
Clothes	25
Transportation	10
Taxes and Social Sec.	65
Medical and Dental	0
Entertainment	15
Personal	45
Other +	15
TOTAL	$ 300

LOAN IS FOR Stereo set
COST $ 83
Your initials

Loan Applicant's Name C. Rado
Occupation Secretary
Monthly Income $ 420
Monthly Expenses

Rent	$ 40
Food	50
Utilities	6
Clothes	40
Transportation	90
Taxes and Social Sec.	95
Medical and Dental	20
Entertainment	20
Personal	30
Other +	22
TOTAL	$ 413

LOAN IS FOR Vacation
COST $ 167
Your initials

Loan Applicant's Name K. Royal
Occupation Office manager
Monthly Income $ 700
Monthly Expenses

Rent	$ 185
Food	60
Utilities	25
Clothes	75
Transportation	15
Taxes and Social Sec.	140
Medical and Dental	20
Entertainment	80
Personal	50
Other +	—
TOTAL	$ 650

LOAN IS FOR Used car
COST $ 333
Your initials

Loan Applicant's Name V. Antal
Occupation File Clerk
Monthly Income $ 293.60
Monthly Expenses

Rent	$ 40
Food	40
Utilities	5
Clothes	35
Transportation	—
Taxes and Social Sec.	76
Medical and Dental	20
Entertainment	20
Personal	30
Other +	—
TOTAL	$ 266

LOAN IS FOR Musical instrument
COST $ 250
Your initials

LOAN OFFICER'S WORKSHEET

(Teacher's Key)

______________ (Your name)

1. Write Loan Applicant's name here: L. Owens

2. Find monthly amount available for loan.

Monthly amount available for loan = Applicant's monthly income minus Applicant's monthly expenses

Applicant's monthly income	$ 320
− Applicant's monthly expenses	$ 300
Monthly amount available for loan	$ 20

3. Write cost of item for which Applicant wishes loan: $ 83

4. Calculate total cost of loan.

Total cost of loan = Cost of item + 20% x Cost of item + Service charge

- Cost of item + 20% x Cost of item:

Cost of item	$ 83.
+ 20% x Cost of item	$ 16.6
Basic amount	$ 99.60

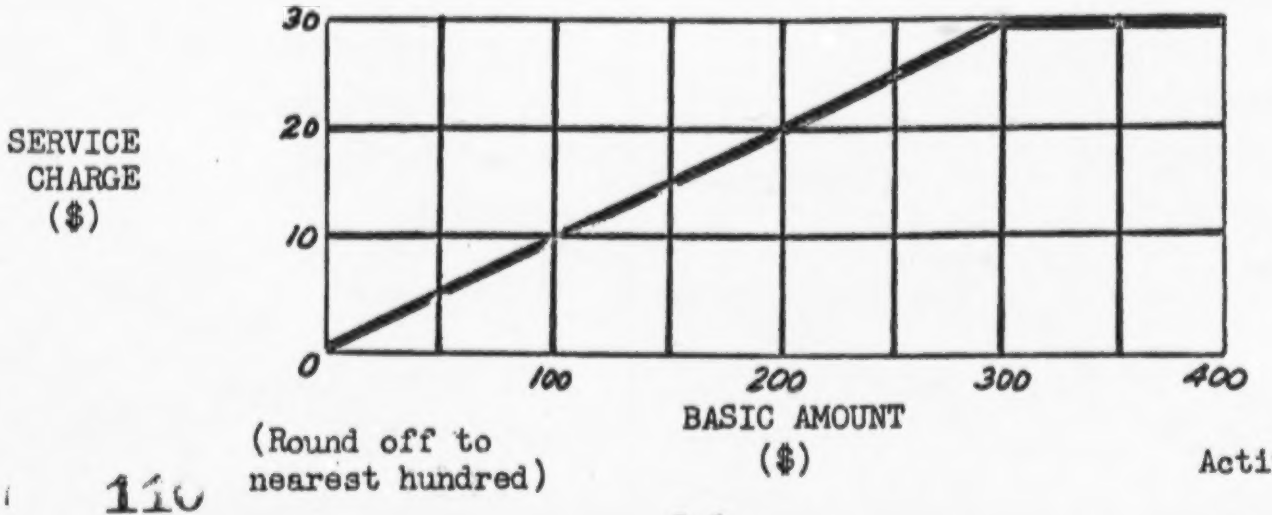
Note: $20\% = \frac{1}{5}$

$20\% = .2$

$$\begin{array}{r} \$83 \\ \times\ .2 \\ \hline \$16.6 \end{array}$$

- Service charge

(Use this curve to find Service charge)



(Round off to nearest hundred)

LOAN OFFICER'S WORKSHEET
(Teacher's Key)

Add Basic amount and Service charge.

Basic amount $ 99.60
+ Service charge $ 10.
$ 109.60 Total cost of loan

5. Find Monthly loan payments for 1-year period (12 months).

$ 9.13 Monthly payment for loan
12) $ 109.60 Total cost of loan
108
16
12
40

6. Compare Loan Applicant's Monthly amount available for loan with Monthly payment for loan.

Loan Applicant's monthly amount available for loan: $ 20.
(See item 2.)

Monthly payment for loan: $ 9.13
(See item 5.)

Note: Loan Applicant's Monthly amount available for loan must be equal to, or greater than, the Monthly payment for loan.

7. Decide whether Applicant qualifies for loan.

Applicant qualifies for loan ✓
(Check one)
Applicant does not qualify for loan ___

____
(Signed)
Loan Officer

LOAN OFFICER'S WORKSHEET

(Teacher's Key)

________________ (Your name)

1. Write Loan Applicant's name here: C. Rado

2. Find monthly amount available for loan.

Monthly amount available for loan = Applicant's monthly income minus Applicant's monthly expenses

Applicant's monthly income	$ 420
− Applicant's monthly expenses	$ 413
Monthly amount available for loan	$ 7

3. Write cost of item for which Applicant wishes loan: $ 167

4. Calculate total cost of loan.

Total cost of loan = Cost of item + 20% x Cost of item + Service charge

- Cost of item + 20% x Cost of item:

Cost of item	$ 167.
+ 20% x Cost of item	$ 33.4
Basic amount	$200.40

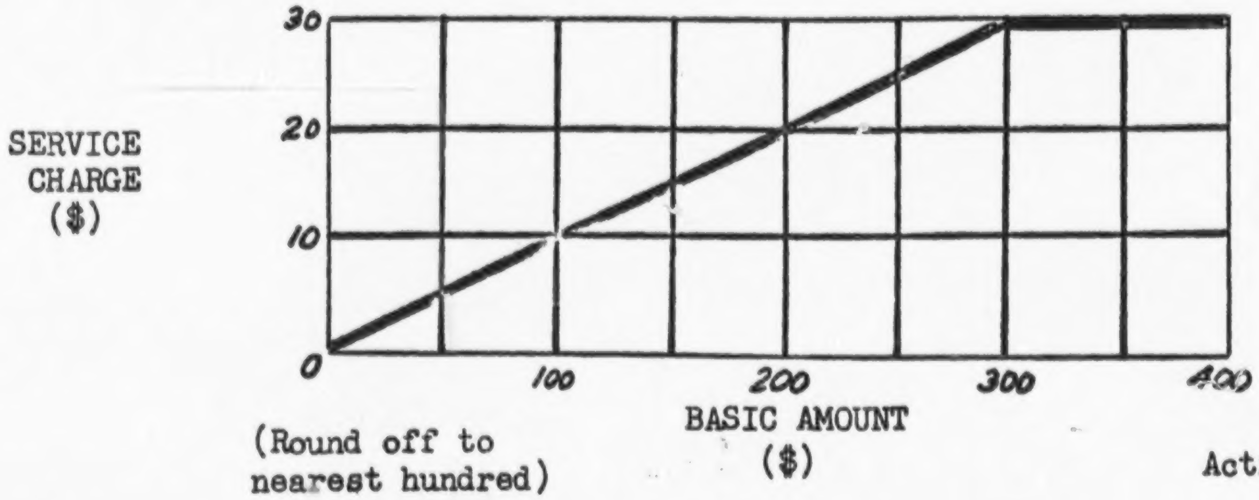
Note: 20% = $\frac{1}{5}$

20% = .2

$$\begin{array}{r} \$167 \\ \times\ .2 \\ \hline \$33.4 \end{array}$$

- Service charge

(Use this curve to find Service charge)



(Round off to nearest hundred)

LOAN OFFICER'S WORKSHEET
(Teacher's Key)

Add Basic amount and Service charge.

Basic amount $ 200.40
+ Service charge $ 20
$ 220.40 Total cost of loan

5. Find Monthly loan payments for 1-year period (12 months).

$ 18.37 Monthly payment for loan
12 | $ 220.40 Total cost of loan
12
100
96
44
36
80
72
8
12

6. Compare Loan Applicant's Monthly amount available for loan with Monthly payment for loan.

Loan Applicant's monthly amount available for loan: $ 7
(See item 2.)

Monthly payment for loan: $ 18.37
(See item 5.)

Note: Loan Applicant's Monthly amount available for loan must be equal to, or greater than, the Monthly payment for loan.

7. Decide whether Applicant qualifies for loan.

Applicant qualifies for loan ___
Applicant does not qualify for loan ✓ (Check one)

(Signed)

Loan Officer

LOAN OFFICER'S WORKSHEET

(Teacher's Key)

____
(Your name)

1. Write Loan Applicant's name here: K. Royal

2. Find monthly amount available for loan.

Monthly amount available for loan = Applicant's monthly income minus Applicant's monthly expenses

Applicant's monthly income $ 700
− Applicant's monthly expenses $ 650
$ 50 Monthly amount available for loan

3. Write cost of item for which Applicant wishes loan: $ 333

4. Calculate total cost of loan.
Total cost of loan = Cost of item + 20% x Cost of item + Service charge

* Cost of item + 20% x Cost of item:

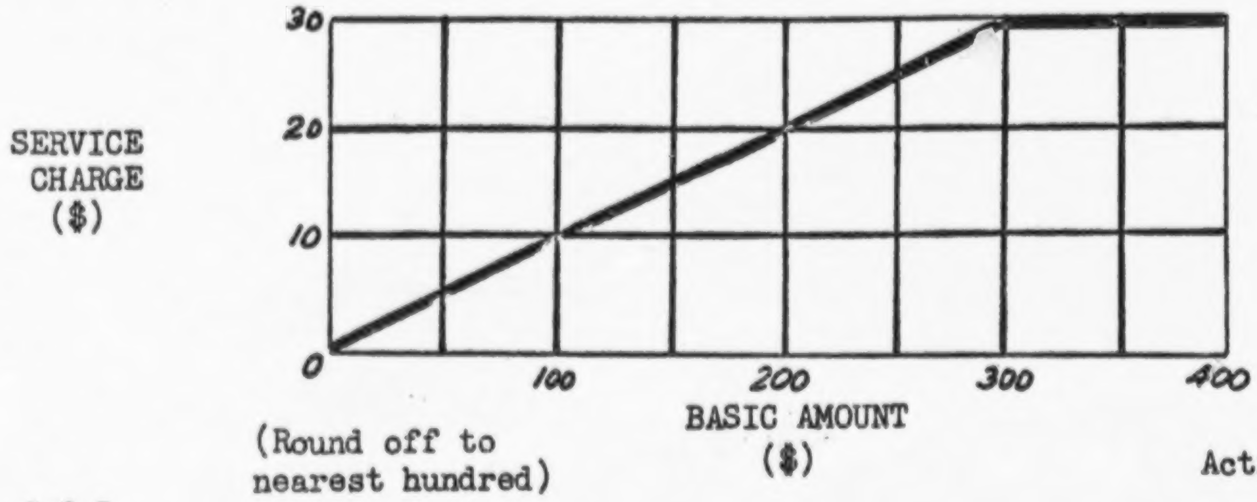
Cost of item $ 333.
+ 20% x Cost of item $ 66.6
$ 399.60 Basic amount

Note: $20\% = \frac{1}{5}$
$20\% = .2$

$$\begin{array}{r} \$333 \\ \times .2 \\ \hline \$66.6 \end{array}$$

* Service charge

(Use this curve to find Service charge)



(Round off to nearest hundred)

LOAN OFFICER'S WORKSHEET
(Teacher's Key)

Add Basic amount and Service charge.

Basic amount $ 399.60
+ Service charge $ 30.
$ 429.60 Total cost of loan

5. Find Monthly loan payments for 1-year period (12 months).

$ 35.80 Monthly payment for loan
12) $429.60 Total cost of loan
36
69
60
96
96
0

6. Compare Loan Applicant's Monthly amount available for loan with Monthly payment for loan.

Loan Applicant's monthly amount available for loan: $ 50
(See item 2.)

Monthly payment for loan: $ 35.80
(See item 5.)

Note: Loan Applicant's Monthly amount available for loan must be equal to, or greater than, the Monthly payment for loan.

7. Decide whether Applicant qualifies for loan.

Applicant qualifies for loan ✓
(Check one)
Applicant does not qualify for loan ___

____
(Signed)

Loan Officer

LOAN OFFICER'S WORKSHEET
(Teacher's Key)

____
(Your name)

1. Write Loan Applicant's name here: V. Antal

2. Find monthly amount available for loan.

Monthly amount available for loan = Applicant's monthly income minus Applicant's monthly expenses

Applicant's monthly income	$ 293.60
− Applicant's monthly expenses	$ 266
	$ 27.60 Monthly amount available for loan

3. Write cost of item for which Applicant wishes loan: $ 250

4. Calculate total cost of loan.
Total cost of loan = Cost of item + 20% x Cost of item + Service charge

* Cost of item + 20% x Cost of item:

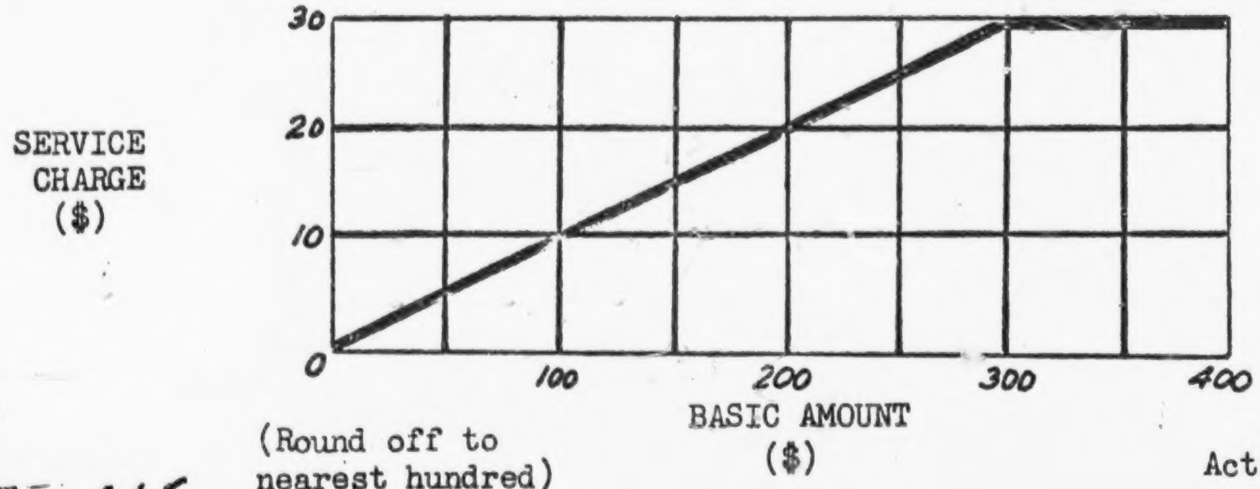
Cost of item	$ 250
+ 20% x Cost of item	$ 50
	$ 300 Basic amount

Note: $20\% = \frac{1}{5}$
$20\% = .2$

$250
× .2
$50.0

* Service charge

(Use this curve to find Service charge)



Activity 9

LOAN OFFICER'S WORKSHEET
(Teacher's Key)

Add Basic amount and Service charge.

Basic amount $ 300
+ Service charge $ 30
$ 330 Total cost of loan

5. Find Monthly loan payments for 1-year period (12 months).

$ 27.50 Monthly payment for loan

$$\begin{array}{r|l} & \$330.00 \\ 12 & \underline{24} \\ & \ 90 \\ & \underline{\ 84} \\ & \ \ 60 \\ & \underline{\ \ 60} \\ & \ \ \ 0 \end{array}$$

Total cost of loan

6. Compare Loan Applicant's Monthly amount available for loan with Monthly payment for loan.

Loan Applicant's monthly amount available for loan: $ 27.60
(See item 2.)

Monthly payment for loan: $ 27.50
(See item 5.)

Note: Loan Applicant's Monthly amount available for loan must be equal to, or greater than, the Monthly payment for loan.

7. Decide whether Applicant qualifies for loan.

Applicant qualifies for loan ✓
(Check one)
Applicant does not qualify for loan ___

(Signed)
Loan Officer

Note: Use this form for keeping track of distributed and returned mtls.

DISTRIBUTION AND COMPLETION CHECKLIST

	L. Owens Cashier		C. Rado Secretary		K. Royal Office Mgr.		V. Antal File Clerk	
STUDENT NAMES	OUT	IN	OUT	IN	OUT	IN	OUT	IN

Note: One required for each student. Separate into four parts. Student works on one part at a time.

LOAN APPLICANTS'
DATA

Loan Applicant's Name L. Owens
Occupation Cashier
Monthly Income $ 320
Monthly Expenses

Rent	$ 80
Food	40
Utilities	5
Clothes	25
Transportation	10
Taxes and Social Sec.	65
Medical and Dental	0
Entertainment	15
Personal	45
Other +	15
TOTAL	$

LOAN IS FOR Stereo set
COST $83
Your initials

Loan Applicant's Name C. Rado
Occupation Secretary
Monthly Income $ 420
Monthly Expenses

Rent	$ 40
Food	50
Utilities	6
Clothes	40
Transportation	90
Taxes and Social Sec.	95
Medical and Dental	20
Entertainment	20
Personal	30
Other +	22
TOTAL	$

LOAN IS FOR Vacation
COST $ 167
Your initials

Loan Applicant's Name K. Royal
Occupation Office manager
Monthly Income $ 700
Monthly Expenses

Rent	$185
Food	60
Utilities	25
Clothes	75
Transportation	15
Taxes and Social Sec.	140
Medical and Dental	20
Entertainment	80
Personal	50
Other +	—
TOTAL	$

LOAN IS FOR Used Car
COST $ 333
Your initials

Loan Applicant's Name V. Antal
Occupation File Clerk
Monthly Income $ 293.60
Monthly Expenses

Rent	$ 40
Food	40
Utilities	5
Clothes	35
Transportation	—
Taxes and Social Sec.	76
Medical and Dental	20
Entertainment	20
Personal	30
Other +	—
TOTAL	$

LOAN IS FOR Musical instrument
COST $250
Your initials

Note: Four required for each student

LOAN OFFICER'S WORKSHEET

____
(Your name)

1. Write Loan Applicant's name here: ____________________

2. Find monthly amount available for loan.

Monthly amount available for loan = Applicant's monthly income minus Applicant's monthly expenses

Applicant's monthly income	$
− Applicant's monthly expenses	$
Monthly amount available for loan	$

3. Write cost of item for which Applicant wishes loan: $ ____________

4. Calculate total cost of loan.
Total cost of loan = Cost of item + 20% x Cost of item + Service charge

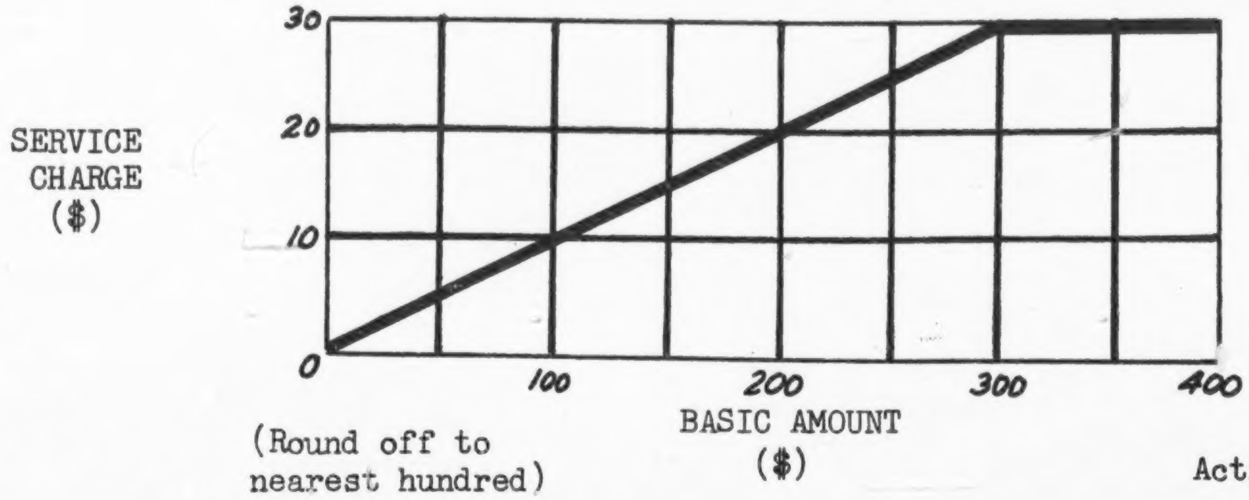
* Cost of item + 20% x Cost of item:

Cost of item	$
+ 20% x Cost of item	$
Basic amount	$

Note: $20\% = \frac{1}{5}$
$20\% = .2$

* Service charge

(Use this curve to find Service charge)



(Round off to nearest hundred)

Activity 9

LOAN OFFICER'S WORKSHEET

Add Basic amount and Service charge.

Basic amount $
+ Service charge $ ______________
$ ______________ Total cost of loan

5. Find Monthly loan payments for 1-year period (12 months).

$ ______________ Monthly payment for loan
$12\overline{)\$\qquad}$ Total cost of loan

6. Compare Loan Applicant's Monthly amount available for loan with Monthly payment for loan.

Loan Applicant's monthly amount available for loan: $ ______________
(See item 2.)

Monthly payment for loan: $ ______________
(See item 5.)

Note: Loan Applicant's Monthly amount available for loan must be equal to, or greater than, the Monthly payment for loan.

7. Decide whether Applicant qualifies for loan.

Applicant qualifies for loan ___
(Check one)
Applicant does not qualify for loan ___

____
(Signed)

Loan Officer

Activity 3
TRANSPORTATION COMMISSION STUDY

SUMMARY

The activity begins with an introduction by the teacher into the background of urban transportation planning. Students are placed in the roles of mathematical analysts or systems engineers who are investigating proposed, alternative urban transit connections. Students are provided with a transit system map that shows various methods for linking the main and suburban communities. In a simple initial exercise, they identify various systems on the map by associating them with descriptive statements. Subsequently, they follow both printed and verbal instructions concerning the totaling of alternate routes and comparing of them to determine the best transportation system. This entails addition and subtraction of numbers and the entering of numbers in specially prepared tables.

SOLO'S

1. The student can follow verbal and printed instructions to complete a Transportation Commission Study
2. The student can correctly add a column of ten 2-digit numbers
3. The student can correctly subtract one 3-digit number from another 3-digit number

MATERIALS

1. Pencils
2. One packet of Activity 3 Student Materials for each student
3. One sheet of scratch paper for each student

TEACHER'S GUIDE

1. Start the activity by telling the class that they are about to take part in a simulation that is being duplicated in real life in cities all over the world. The class is going to look into the way that engineers help with the planning of large transporation systems. Tell the class that the United States is a country of big cities. People depend on transportation more than ever before to ge to and from their jobs, schools, recreational areas, shopping, etc. Ask for volunteers to comment on the various forms of city public transportation that they have used. Ask the students to tell whether they would like to see changes to the public transportation system, and invite them to make specific recommendations.

2. Impress on the class that transportation systems are so vital to the well-being of cities that millions of dollars are being spent just to look into the problems and needs --before any construction is done. Tell the class that city planners and engineers work with the community in determining the costs and advantages of various types of systems before a particular one is recommended to be built.

3. Tell the class that in this simulation they will look into five geometric arrangements of tracks representing alternate possibilities for a rapid transit system designed to serve an urban area.

4. The students will identify each system map by associating it with a descriptive statement.

5. The students will then calculate the total number of miles of track that make up each system.

6. Next, from the point of view of the City Council of Hispaniola, the students will choose the best system. They will do this by:

   Finding the distance from Hispaniola to each other, for each system. To do this, the student consults the System Map and fills out Table 1.

The complete system (System V) gives the shortest distances from city to city. Therefore, Table 2 (which shows mileage penalties for each system) shows a penalty of zero for all System V journeys.

In the row for every other system, the student lists "mileage penalties," which are additional track miles that must be built between Hispaniola and each other city if the complete system is not built.

To do this, the student subtracts the mileage for the complete system from the mileage for the system under investigation. To do so, he refers to data in Table 1 and enters his results in Table 2.

The Hispaniola-Benbow route appears twice in Table 2. This is because Benbow is a large city, and more people travel between Hispaniola and Benbow than between Hispaniola and the other cities. So, Benbow has a double effect on the comparison.

In the right-hand column of Table 2, all the penalties must be added (across the row) for each of the five systems. Of course, System V has a total penalty of zero.

In Table 3, the student makes a final comparison among the five systems. He does so by adding the total number of miles of track to build each system (from Table 1) to the penalty for each system (from Table 2). The sum in the right-hand column of Table 3 is the System Score. A low score implies a good system. A good system has a relatively low cost (low number of track miles) and relatively good utlity for Hispaniola (low penalty). Each student selects the winning system from his Table 3 conclusions.

7. It is vital that these two aspects of the simulation be made clear to the student:

   a. They are enacting the roles of mathematical analysts or systems engineers who are assisting a city council to make a decision that will be based on the cost and utility of various choices.

   b. They are carrying out their analysis in behalf of only one city council (Hispaniola's). Therefore, the utility factor relates only to that city. Since Hispaniola must contribute to the cost of building the entire system, the total track mileage is also an important factor.

   If the analysis were being made in behalf of some other city, the bases for comparison would be different, and a different penalty table would be needed.

TRANSPORTATION COMMISSION STUDY
(Teacher's Key)

1. You are a member of a Transportation Commission studying five proposed transit systems for the Benbow Urban Area.
2. Look at your Rapid Transit System map.
    - Benbow is the largest city
    - The other names are for suburbs (smaller cities)
3. The Rapid Transit System map shows five different ways to connect the cities.
    - Each plan has a Roman numeral below it
    - The numbers are distances in miles between cities
4. Read the descriptions below for the five types of transit systems.
    - In the space provided, write the number of the plan on the Rapid Transit System Map that fits the description.

System Number (Roman numeral)	Description
II	The TOUR SYSTEM connects each city to neighboring cities in such a way that passengers can make a fairly circular tour of the entire area.
IV	The MULTI-REMOTE STATION SYSTEM has several outlying stations so passengers may change routes or go around a city without going into it.
III	The SINGLE STATION SYSTEM has one outlying station so passengers may change routes.
V	The COMPLETE SYSTEM combines the Central System and the Tour System.
I	The CENTRAL SYSTEM connects most cities directly to the central city.

Teacher's Key, Cont'd

5. Compute the total miles of track needed to construct each system. (Do not use a ruler. The distances in the Rapid Transit System map are not shown to scale.)

System	Total Miles
Central System	135
Tour System	153
Single Remote Station System	127
Multi-Remote Station System	173
Complete System	242

6. The City Council of Hispaniola will decide which of the five plans to support.

The Complete System has the shortest travel distance and least travel time between Hispaniola and each other city.

Table 2 lists the extra distance between Hispaniola and each other city, for each of the four plans. Extra distance, or penalty distance, is how much farther a route would be than that of the Complete System.

When you fill out Table 2, subtract mileage on the Complete System from each mileage.

DATA SHEET
(Teacher's Key)

TABLE 1
MILES FROM HISPANIOLA TO EACH OTHER CITY

	CITY					
SYSTEM	Benbow	Flint	Gunn	Hawkins	Silver	Smollett
I	38	68	56	57	65	59
II	58 ~~86~~	29	40	67	49	22
III	38	53	56	57	65	28
IV	38	53	48	62	57	28
V	38	29	40	57	49	22

59

22

Example

59 minus
22 equals
37.

TABLE 2
MILEAGE PENALTY

(How many extra miles are there from Hispaniola to each other city if the complete system is not built.)

	CITY							
	See Note below							TOTAL PENALTY
SYSTEM	Benbow	Benbow	Flint	Gunn	Hawkins	Silver	Smollet	
I	0	0	39	16	0	16	37	98
II	20	20	0	0	10	0	0	50
III	0	0	24	16	0	16	6	62
IV	0	0	24	8	5	8	6	51
V	0	0	0	0	0	0	0	0

TABLE 3
SYSTEM SCORES

SYSTEM	TOTAL PENALTY +	TOTAL MILES OF TRACK =	SYSTEM SCORE
I	98	135	233
II	50	153	203
III	62	127	189
IV	51	173	224
V	0	242	242

Note: Penalties for Benbow are written twice because it is a big city, and more people go to and from Benbow.

THE BEST SYSTEM (LOWEST SYSTEM SCORE) IS III.

TRANSPORTATION COMMISSION STUDY

1. You are a member of a Transportation Commission studying five proposed transit systems for the Benbow Urban Area.
2. Look at your Rapid Transit System map.
   - Benbow is the largest city
   - The other names are for suburbs (smaller cities)
3. The Rapid Transit System map shows five different ways to connect the cities.
   - Each plan has a Roman numeral below it
   - The numbers are distances in miles between cities
4. Read the descriptions below for the five types of transit systems.
   - In the space provided, write the number of the plan on the Rapid Transit System Map that fits the description.

System Number (Roman numeral)	Description
______	The TOUR SYSTEM connects each city to neighboring cities in such a way that passengers can make a fairly circular tour of the entire area.
______	The MULTI-REMOTE STATION SYSTEM has several outlying stations so passengers may change routes or go around a city without going into it.
______	The SINGLE STATION SYSTEM has one outlying station so passengers may change routes.
______	The COMPLETE SYSTEM combines the Central System and the Tour System.
______	The CENTRAL SYSTEM connects most cities directly to the central city.

5. Compute the total miles of track needed to construct each system. (Do not use a ruler. The distances in the Rapid Transit System map are not shown to scale.)

System	Total Miles
Central System	________
Tour System	________
Single Remote Station System	________
Multi-Remote Station System	________
Complete System	________

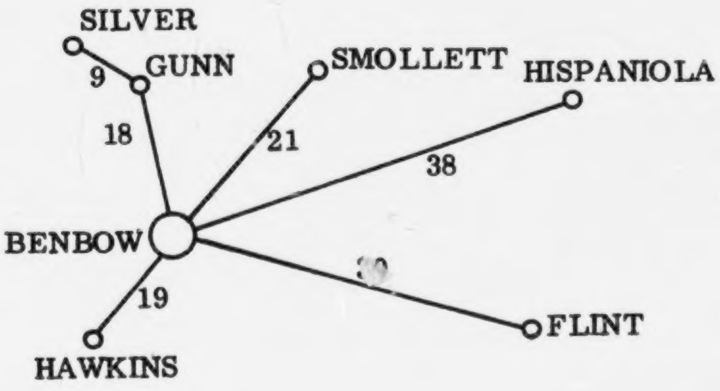
6. The City Council of Hispaniola will decide which of the five plans to support.

The Complete System has the shortest travel distance and least travel time between Hispaniola and each other city.

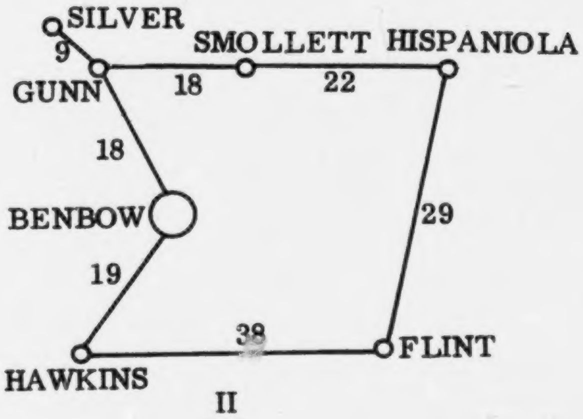
Table 2 lists the extra distance between Hispaniola and each other city, for each of the four plans. Extra distance, or penalty distance, is how much farther a route would be than that of the Complete System.

When you fill out Table 2, subtract mileage on the Complete System from each mileage.

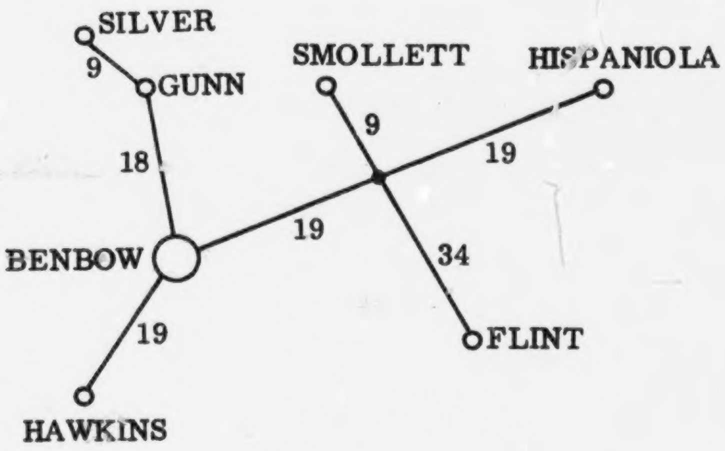
Rapid Transit System Map



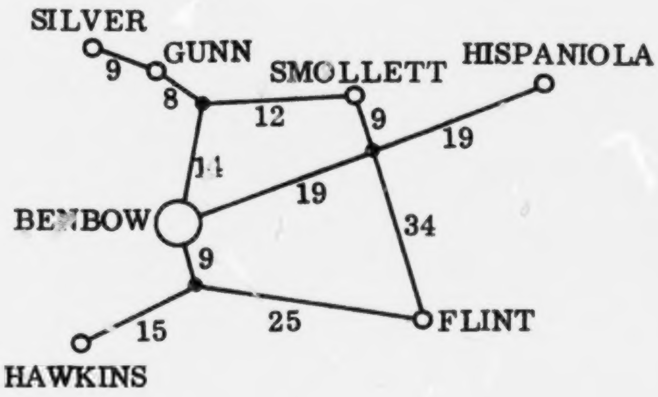
I



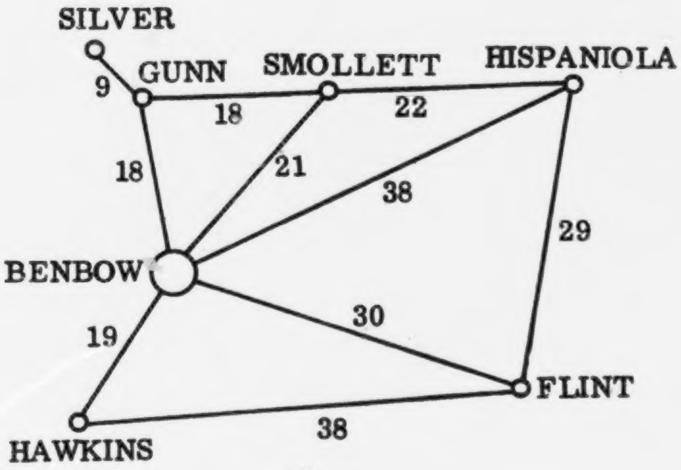
II



III



IV



V

○ CITIES

● OUTLYING STATIONS

Note: Distances are not drawn to scale

DATA SHEET

TABLE 1
MILES FROM HISPANIOLA TO EACH OTHER CITY

	CITY					
SYSTEM	Benbow	Flint	Gunn	Hawkins	Silver	Smollett
I						
II						
III						
IV						
V						

TABLE 2
MILEAGE PENALTY

(How many extra miles are there from Hispaniola to each other city if the complete system is not built.)

	CITY							TOTAL PENALTY
	See Note below							
SYSTEM	Benbow	Benbow	Flint	Gunn	Hawkins	Silver	Smollet	
I								
II								
III								
IV								
V	0	0	0	0	0	0	0	0

TABLE 3
SYSTEM SCORES

SYSTEM	TOTAL PENALTY	+	TOTAL MILES OF TRACK	=	SYSTEM SCORE
I					
II					
III					
IV					
V					

Note: Penalties for Benbow are written twice because it is a big city, and more people go to and from Benbow.

THE BEST SYSTEM (LOWEST SYSTEM SCORE) IS ________________.

THIS ACTIVITY REQUIRES ADVANCE PREPARATION OF MATERIALS BY THE TEACHER

Activity 3

BUSINESS TELEPHONE CALL

SUMMARY

Following a brief introduction by the teacher into the elements of an effective business telephone call, the students are told how they will engage in a simulated call. Students are assigned to work in pairs. One student (or pair) reads information telling about a call he is to make. Another student (or pair) reads information on a call he will receive. The students prepare notes and, using cardboard cutouts of telephones, conduct the business call. At the end of their conversation, the entire class rates them on a score sheet with respect to courtesy, timing, and coverage of information. The exercise is repeated, with different call sheets distributed to different students (or pairs of students). At the teacher's option, scores may be tallied at the end of the period, and winners announced.

SOLO

The student can conduct a 5-minute telephone conversation and successfully convey information eliciting a "business" decision.

MATERIALS

1. Pencils
2. One set of Activity 3 Student Materials for each student
3. A pair of dice for each class
4. A pair of cardboard strips (approximately 9" x 3") for simulated telephones
   (THESE MUST BE PREPARED BEFORE THE ACTIVITY IS CONDUCTED.)
   Obtain cardboard strips from R-3 Office Supplies.

TEACHER'S GUIDE

1. Spend a few minutes talking about the importance of the telephone to the daily operations of offices. Ask the students to tell what they think is important in any telephone conversation. Write all relevant factors such as courtesy, timing, and coverage (of information) on the chalkboard.

2. Tell the class that a great deal of time and effort are spent by telephone companies in helping business and industry to use their telephones effectively. Explain the expression "meeting the public." Point out that in many businesses, industries, and public services, the person who takes telephone calls "meets the public" and "speaks for his organization." Tell the class that if they were to call a bank or clothing store and were treated rudely or inefficiently, they might decide not to do business with that firm.

3. Tell the class that today they will take part in simulated business telephone calls. Ask the class to explain the difference between a personal call and a business call. Point out that a person may be friendly and and thoughtful during a business call. The main difference is that in a business call there is an exchange of information that usually leads to a decision. For this reason, a business call should be planned beforehand. A person should know what he wants to say, what he wants the other person to do, etc.

4. Explain how the simulated business calls will be made. Only one call will be made at a time. While the call is being made, the rest of the class will be listening and observing. When the call is completed, the class members will fill in a rating sheet. Then another call will be made, and the process will be repeated.

5. Students will use two simple cardboard cutouts of telephones. TWO OF THESE MUST BE PREPARED BEFORE THE ACTIVITY IS CONDUCTED. THEY MUST BE AVAILABLE ON THE DAY THE ACTIVITY IS PERFORMED.

6. Hand out a set of Activity 3 Student Materials to each student. Tell the class to spend a few minutes looking the material over.

7. Preferably, select the two most outgoing students in the class to serve as the first callers. In this first "call," as well as succeeding ones, allow each caller to select a partner to help him with the call. This is optional. If a student would prefer to conduct the call completely on his own, this is acceptable. In some instances, students will need the assurance of a classmate seated alongside.

8. Withdraw a page from the six simulated calls provided in the Teacher's Material. Cut the page in half, and give one part to one of the students or pairs of students) and another part to the other student (or pair of students). Tell the students (or pairs of students) to read the materials. Also, give each student (or pair of students) a single die.

9. Explain to the entire class what is happening. Tell the class that one student (or pair of students) is reading information that tells them about a call they are to make. The other student (or pair of students) is reading information about a call they will receive. When both are ready, the call will be made, and the rest of the class will listen attentively.

10. Tell the class that they do not have to know what is printed on the pages that the callers are reading. The rest of the class will find out by listening. Refer the class to their Telephone Call Score Sheets. Tell them to rate the two parties in courtesy, timing, and coverage. Tell them not to mark their score sheets until the call is completed. For each call, there should be a rating on two lines (students should write in the names of the the calling parties).

11. There may be some questions concerning the factor of "timing" on the score sheet. Tell the class that every telephone conversation must be direct and and to the point. If a caller causes a conversation to drag on with nothing accomplished, that caller should be rated "1." However, if a caller spends a comparatively long time speaking, but still accomplishes something useful during the conversation, that caller could be rated a "4."

12. Returning to the two callers (or pairs of callers), be specific in their instructions. The person placing the call is asking for something to be done. The person receiving the call must decide at the end of the call whether or not permission is granted. The decision cannot be left "hanging."

13. Tell the entire class that one of the measures of effectiveness of the caller is whether or not the person being called grants permission.

14. Tell the two students (or two pairs of students) who will be engaging in in the telephone call to roll their die three times and mark the appropriate statements on their Worksheets. Tell those students that the statements they check should be followed as they carry on their conversations.

15. Give each caller or pair of callers a cardboard cutout of a telephone, and tell them to begin.

16. For the first and second "calls," be prepared to help the callers to get started. Discourage "huddling" between callers. Point out that the reason for having someone stand by is to provide a source of information if the caller cannot answer a question himself.

17. The teacher should be satisfied that the person making the call has spent enough time reading the information on his call sheet and organizing notes.

    The person receiving the call should, too, be familiar with his role and should be prepared to ask certain questions.

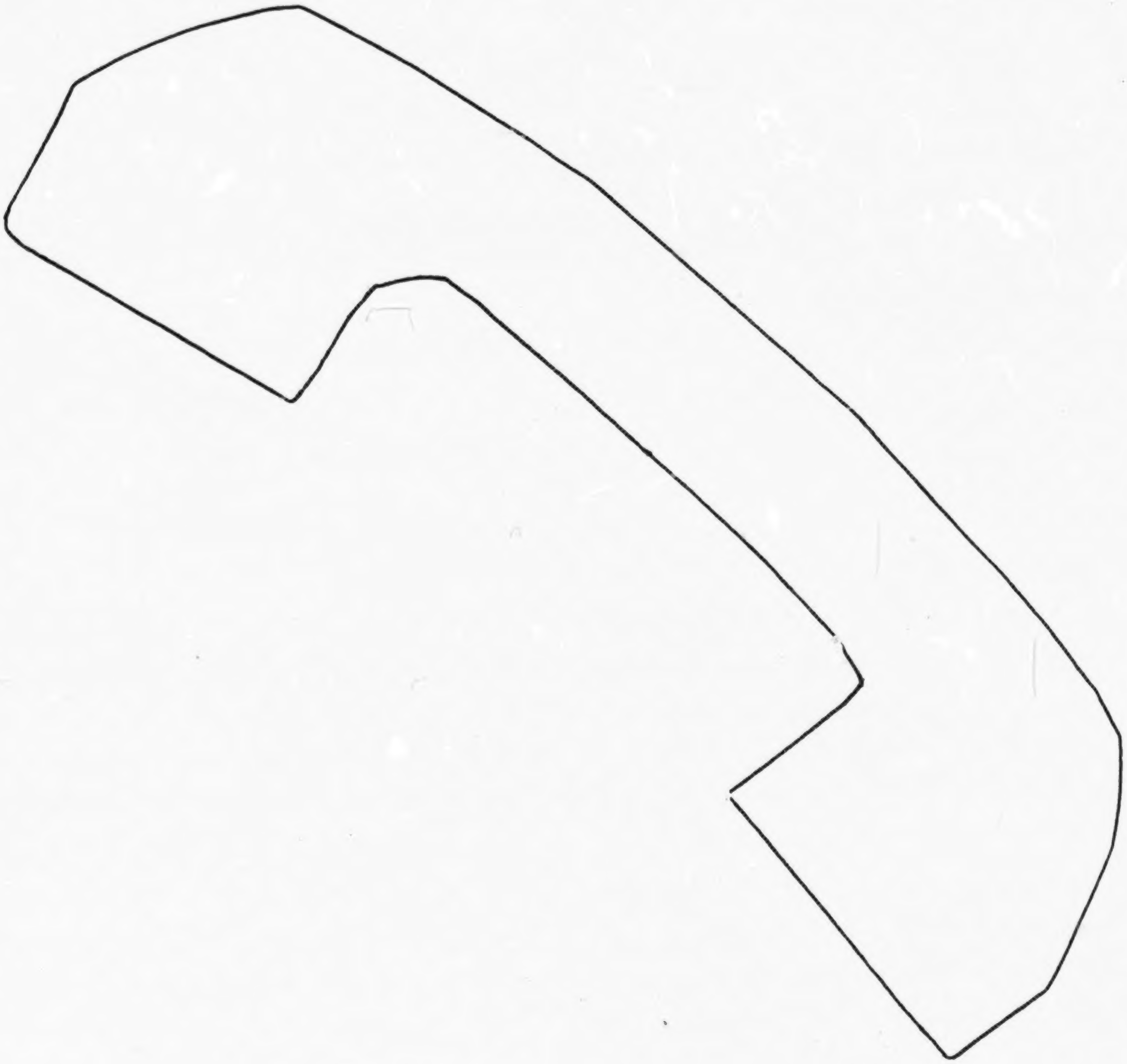
18. After each pair of students have completed a call, have the class rate them.

19. After the last call is completed, and all "scores" have been entered on the worksheets, the teacher may wish to poll results and announce them.

PATTERN FOR SIMULATED TELEPHONES

Instructions to Teacher:

1. Obtain two strips of cardboard (approx. 9" x 3")
2. Trace this pattern onto the strips
3. Cut out both simulated telephones and set them aside until the activity is conducted



CALL NO. 1A

Instructions:

You and a friend were walking home from school yesterday. Suddenly you both saw something in the sky. It was colored red, white and blue. It gave off an orange flame. It started rising in the sky very fast, and disappeared. You and your friend have never seen anything like it in your lives. You both believe it was a "flying saucer." You have both decided to call the local newspaper and tell them what you saw. Insist that they should print a story on it. Give them reasons why they should print the story.

The newspaper editor may think you are joking, but you are not. You really did see something that looked like a flying saucer. The newspaper may refuse to print the story in his paper. You must tell him why he should print it.

He may ask you how old you are. If he does, tell him. But he may doubt that someone your age can be a good observer. Be ready to convince him that you are a responsible person.

CUT HERE

CALL NO. 1B

Instructions:

You are the editor of a newspaper. Your job is to find interesting stories and print them in your paper. People are always calling you up, telling you about something that happened to them, and asking you to print their stories. Some of the callers are liars. You would like to print unusual stories, but you have to be sure of the facts. If you print a ridiculous story, your readers may laugh at your newspaper and stop buying it.

Someone is going to call you about a very unusual story. Find out how old they are. Try to decide whether they are responsible people. They may be trying to play a trick on you. On the other hand, they may have a very important story that will really make your paper sell.

CALL NO. 2A

Instructions:

You are a home owner. You want to move your house to another part of town. You plan to have your house put on a large trailer and moved. But the trailer has to pass through a school yard. This means the fence around the school yard must be taken down. You must call the local superintendent of schools to get permission to have the fence removed. This is a big job that costs a lot of money to do. Try to get the superintendent to have the school district pay for the whole job. He may ask you to give reasons why the district should pay for the job. Tell him that it would be good for community relations to show how the school district cooperates with the citizens. Try to think of other reasons why he should agree to have the fence taken down and pay for the job.

He may ask you why you have to move the house through the school yard. This is the shortest route, and it will be the cheapest way to do it. But if he tells you that's your problem, you may end up with a higher bill by having to go all around the school. So be careful. Try to make a strong case as to why he should cooperate. You have to be very clever.

CUT HERE

CALL NO. 2B

Instructions:

You are the superintendent of schools. You have responsibility over the protection and safety of all school property. Someone is going to call you and ask you for permission to remove the fence around a school yard. They wish to move a house that is on a trailer. After the trailer passes through, the fence will be put up again.

The caller will try to get you to pay for the job of removing the fence and putting it up again. He will tell you this would be good for community relations. It would show how the school district cooperates with the citizens. But you have to know the answers to many questions: Why must the house be moved through the school yard? Will the job interfere with the school's activities? Will any lives or property be endangered? Also, you will have to decide whether you should agree to have the school district pay for the job. Ask the caller to give you reasons why the district should pay. Tell the caller that if the school district pays to do the job, there will be less money for educating students. Make a strong case of your argument.

CALL NO. 3A

Instructions:

You are the president of a club that races dune buggies. You want to stage a race on a local beach. You must get permission from the local beach park supervisor. He may be unwilling to give you permission because of the danger to lives and property. He will ask you to give him reasons why he should agree to let you stage the race. You must be prepared to tell him how you will set up the race so that it will be safe. He may ask you to give some kind of guarantee that if anyone is hurt or anything is damaged, your club will take the responsibility.

You are too young to sign a legal agreement. So, you must have good reasons to make the beach supervisor feel that he should give you permission. You would like to stage the race on a weekend. But the beach is crowded on weekends. You are willing to have the race in the middle of the week, at night, but that is not your first choice. Try to get the beach park supervisor to give into as many of your requests as possible. He will want to know all your plans for the race. If he thinks you don't have good plans, he may refuse permission.

CUT HERE

CALL NO. 3B

Instructions:

You are the supervisor of a public beach. You will be called by the president of a club that races dune buggies. He will request permission to stage a dune buggy race. You can give him permission if you believe that there will be no danger to life or property. But the caller is too young to sign a legal agreement to accept responsibility. Ask him what kind of guarantees he or his club will give. You must be sure that if anyone is hurt or if any property or trees are damaged that someone will pay the bill. There could be court cases if something serious happened. You want to avoid that.

The caller would like to stage the race on the weekend. But the beach is very crowded over the weekend. Ask the caller to give you detailed information on all the plans he has made for the race. Where will people sit? Who will do the policing to make sure no one walks onto the race course? Do not give permission unless you think the caller is responsible and has thought out all his plans.

CALL NO. 4A

Instructions:

You are an R-3 Student. You have been working with educational games and simulations for almost a year. You think other people would like to know about educational games and simulations. You are going to call the editor of a national magazine and invite him to send a reporter to your school. You would like the reporter to see the R-3 games and simulations in action, and write a story for the magazine.

But the editor you are calling has never even heard about educational games and simulations. The only games he knows about are Monopoly, baseball, football, etc. You will have to explain what educational games and simulations are, and you will have to make him interested in looking into them further.

He is a very busy man, and he may think you are just putting him on. So, you must be sure that you have thought out what you will tell him. He may ask you to prove that students learn from educational games and simulations. He may ask you to describe one of the educational games or simulations you have worked with.

CUT HERE

CALL NO. 4B

Instructions:

You are the very busy editor of a national magazine. A student is going to call you and request that you do a story on something going on at his school. This is the first time you have ever heard anything about the subject.

Ask the student to explain what he is talking about. Ask him to tell you why your magazine should do a story on the subject. Ask him why people would be interested in reading about this subject.

The student may tell you that his subject is the greatest thing in the world. He may tell you it's doing a great job. Ask him for proof. Ask him to describe in detail one of the things he is talking about. Ask him why your magazine readers would be interested in this subject. Do not agree to send a reporter to do a story unless you are convinced by the caller.

CALL NO. 5A

Instructions:

You are an R-3 student. The R-3 Project Leader has asked you to call a Scout Camp in the Sierras. Your job is to get the camp superintendent to let the R-3 Project ust the camp for spring field trips. You don't have to worry about the costs. The R-3 Project Office will take care of that part.

The problem is this: The camp superintendent has never had a group of students use his camp before. He will want to know something about the group (how many, how old, how responsible, etc.). He will want to know how the group will handle the overnight arrangements (does he have to supply sheets, blankets, etc.). Also, he will want to know about the plans for eating. Does he have to provide dining room service, or will the group supply its own meals.

Finally, he will want to know what a "field trip" is. You must be prepared to tell him why your group is going on one. Be ready to tell him what the group will do in and around the Scout Camp. You will have to do a job of "selling" him on the idea because he may think the whole thing is a waste of time and effort.

CUT HERE

CALL NO. 5B

Instructions:

You are the superintendent of a Scout Camp in the Sierras. You are going to receive a call from a student. The student will ask you whether his group can come up and use your camp for field trips. You have never heard of a field trip. Ask the student how many students are in his group. Find out what their overnight plans are. Ask what the group plans to do about meals. Are they going to bring up their own food? Who will do the cooking?

But most important, find out why they want to come to your Scout Camp. Ask the student to explain to you exactly what they plan to do there. Ask him to give you examples. You will have to decide whether or not to give them permission. If it sounds as if they want to come up there just to have fun, you should not give permission to use your camp. The must have good reasons.

CALL NO. 6A

Instructions:

You are the entertainment chairman of your club. Your club works on ecology projects, charity projects, and youth projects. Your job is to call a city official and get permission to hold a street dance. You wish to have a city street closed from 7:00 P.M. until about 11:00 P.M. Your club will sell snacks and soft drinks at the street dance and donate the money to a youth club that needs sports equipment. Your club will make all the arrangements for the dance, obtain the band, take care of advertising, etc. But you must get permission from the city official.

The city official would like to help you out, but you will have to convince him. Last month there was a street dance that got out of hand. The city official may ask you to assure him that your street dance will not get out of hand. He will ask how you can guarantee it will not get out of hand. Also, there is a city law which states that there shall be no noise after 10:00 P.M. Be prepared to answer questions on how you plan to keep the street fairly quiet from 10:00 P.M. to 11:00 P.M.

Try to make your case as strong as you can. Even though you have a good cause, the city official has to think about the safety and rights of privacy of all the citizens in the community.

CUT HERE

CALL NO. 6B

Instructions:

You are a city official. You will receive a call from a student whose club wants to hold a street dance. The club would like permission to have one of the city's streets closed to traffic one night from 7:00 P.M. to 11:00 P.M.

You have the power to allow them to use the street. But they must give you good reasons. You can't let everyone have street dances whenever they wish. Ask the caller why you should give permission. Tell him that there was a street dance last month that got out of hand. Ask the caller to tell you how the club will make sure that the dance will not get out of hand. Ask him for details on how the dance will be run. Remind him that there is a local law which states there shall be no noise after 10:00 P.M. How will they make sure it will be quiet? If you think the caller is not mature or responsible, do not give permission.

WORKSHEET

Instructions:

1. Listen carefully to the oral instructions of your teacher.
2. Read the "Call" sheet that you receive.
3. You may be working alone or with a partner.
4. Make notes on this Worksheet before you make (or receive) a call.
5. Also, before a call is made, roll a single die three times to set up 3 more instructions:

Roll the die.

If you roll a 1,2, or 3 start out forcefully, but end gently. ___

If you roll a 4, 5, or 6 start out gently, but end forcefully. ___

CHECK ONE

Roll the die again.

If you roll a 1, 2, or 3 offer to meet the person at the other end of the line. (Have reasons.) ___

If you roll a 4, 5, or 6 refuse to meet the person at the other end of the line. (Have reasons.) ___

CHECK ONE

Roll the die for the last time.

If you roll a 1, 2, or 3 talk with a sense of humor. ___

If you roll a 4, 5, or 6 be very serious. (Don't do any clowning.) ___

CHECK ONE

TELEPHONE CALL
(Score Sheet)

NAME OF CALLER	COURTESY	TIMING	COVERAGE	TOTAL SCORE
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
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	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	
	1 2 3 4	1 2 3 4	1 2 3 4	

Activity 4
LIGHT BULB INSPECTION SIMULATION

SUMMARY

This activity begins with a brief description of the functioning of various parts of a flashlight bulb. The teachers leads the students through a description of the parts, with the students referring to illustrations in their printed materials. The students are told that they are in the roles of flashlight bulb inspectors, and their assignment is to discover the principal causes of trouble in several defective light bulbs. The students refer to a correctly manufactured light bulb (illustration) and compare each of 27 defective bulbs against it. They identify the cause(s) of trouble and mark an "Bulb Inspection Chart."

SOLO'S

1. The student can follow oral instructions correctly and identify 25 out of 27 causes of defect in a set of 27 (simulated) flashlight bulbs

MATERIALS

1. Pencils
2. A packet of Activity 4 Student Materials for each student

Teacher's Guide

1. Each student will play the role of an inspector at the flashlight assembly line. The inspector's assignment is to examine several defective light bulbs to see what the principal causes of trouble are.

   (By implication, the faulty bulbs have already been separated from the good bulbs (probably by a functional testing process -- did the bulb shine at the desired intensity when supplied with electrical energy, or did it not?) Therefore, this simulation does not involve separating good bulbs from bad. It is a diagnostic inspection to determine what kinds of things are going wrong.)

2. The teacher should be sure that the students understand the parts of the bulb and their functional relationships, as shown in the diagram of the isolated bulb.

   - The electricity flows into one lead (at the soldered connection) through the filament, and out through the other lead at its soldered connection.
   - The direction of flow can be taken in either direction, since it is entirely a matter of convention.(The flow of current usually is thought of as going from a positive electric pole to a negative electric pole. However, electrons travel in the opposite direction.) The teacher may choose one lead as the input, for the sake of clarity.
   - The filament, having a high electrical resistance relating to its thinness, becomes incandescent.
   - The leads and filament are incased in a glass bulb from which the air has been pumped out. In this airless condition, the filament does not burn up in its heated condition.

- The dotted lines of the diagram should be carefully explained. The two dotted lines that run parallel to the outer walls of the base of the bulb represent the enclosed portion of the base insulator. The dotted line that runs down the central axis of the base is the extension of the central lead. The dotted line that curves toward the left is the extension of the side lead. Both of these extended leads are soldered into place at the solder tips.

3. After a thorough class discussion about the structure and functioning of the bulb, the students are to receive the packet of Student Materials. Tell the class to examine it. Each student is to enter light bulb numbers into appropriate places on his chart.

BULB INSPECTION CHART

Write bulb numbers on the lines that describe bulb condition. For instance, if bulb number 28 had a broken filament and a bent flange, the number 28 would be written on the lines opposite those two defects. More than one bulb number may be written opposite a single defect.

FILAMENT

Broken 7, 11, 17, 23
Missing 1, 5, 15, 19
Double 3

BULB

Broken 2, 13
Cracked 4, 10, 27
Broken Tip 24

LEADS

Broken 8
Missing 16
Crossed or Tangled 2, 14
Bent 13
Not Soldered 1, 6, 12, 22, 26
Soldered Together 9, 18

INSULATORS

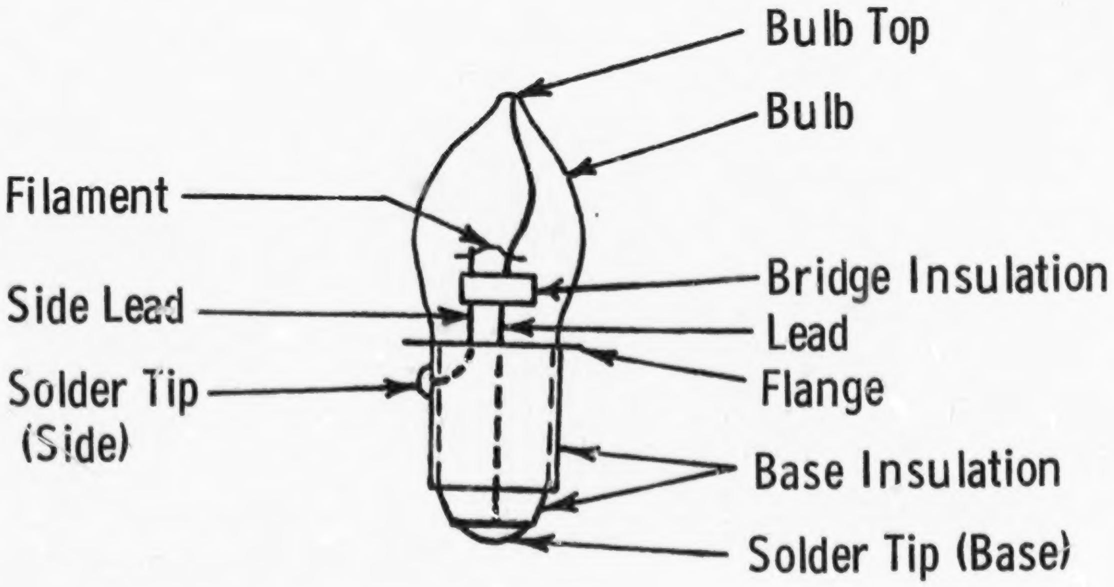
Base insulator cracked 17
Bridge insulator cracked 20
Bridge insulator missing 25

FLANGE

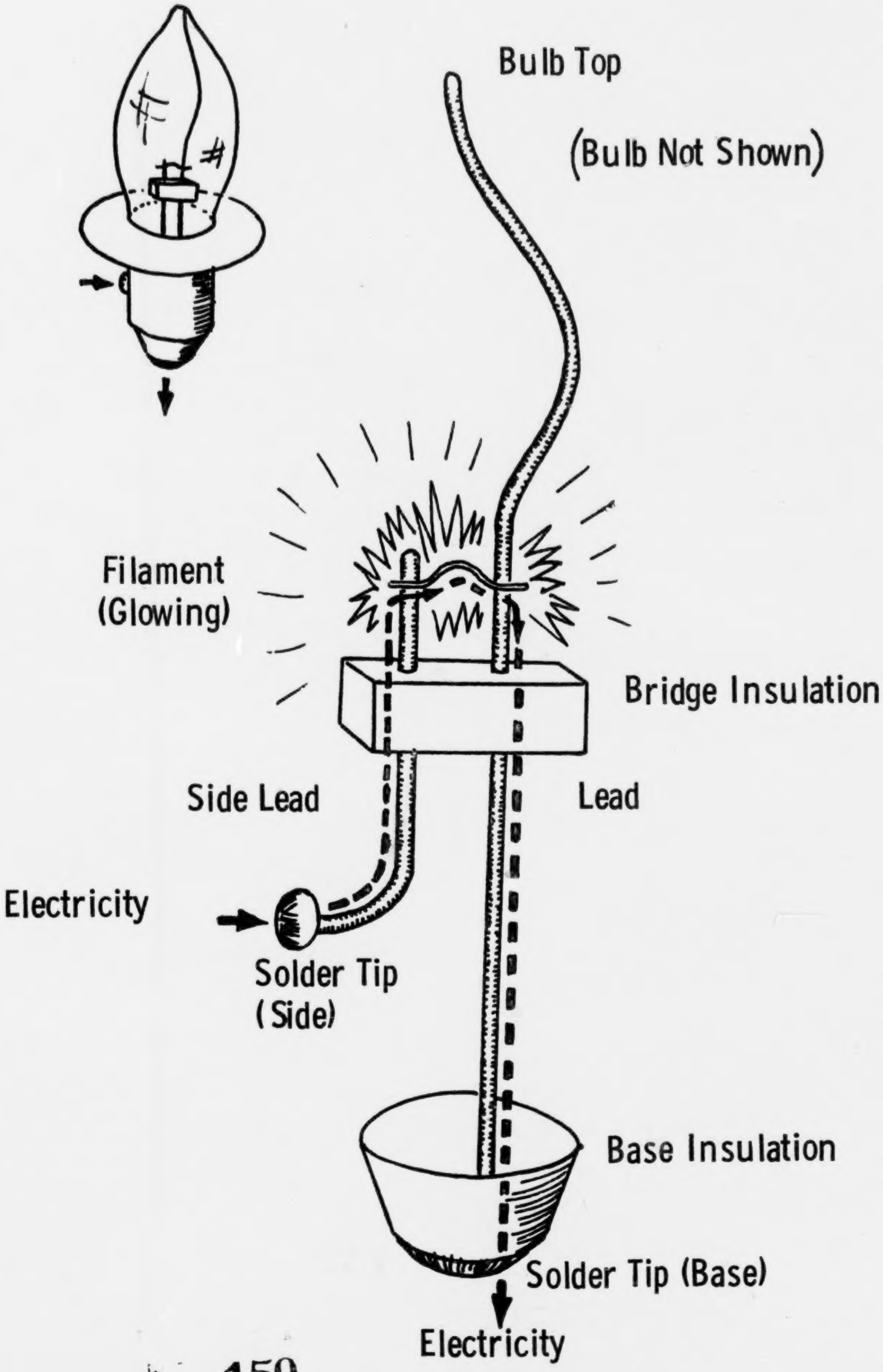
Bent 21

____
(Name)

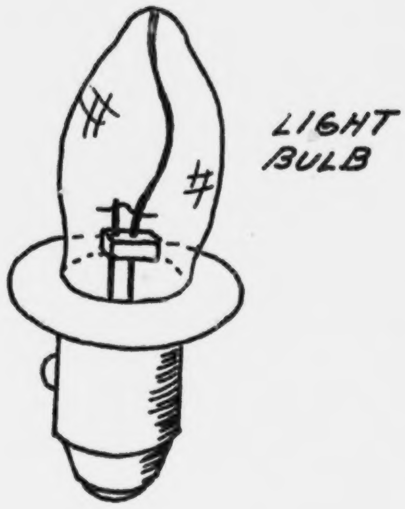
CORRECTLY MANUFACTURED FLASHLIGHT BULB

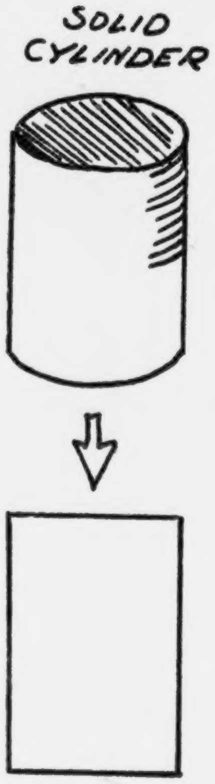


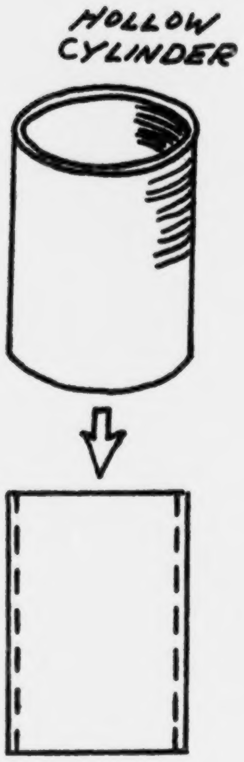
HOW A FLASHLIGHT BULB WORKS



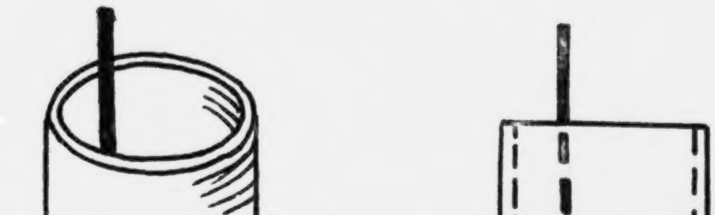
AID TO UNDERSTAND DRAWINGS OF FLASHLIGHT BULBS





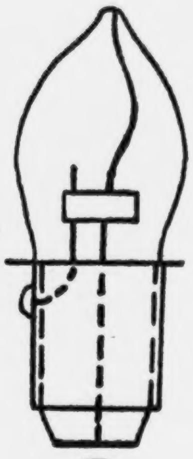


SIDE VIEWS
OF
CYLINDERS



WIRE PASSING THROUGH
CYLINDER AND COMING OUT
OF SIDE-

DEFECTIVE FLASHLIGHT BULBS



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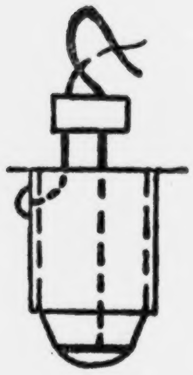

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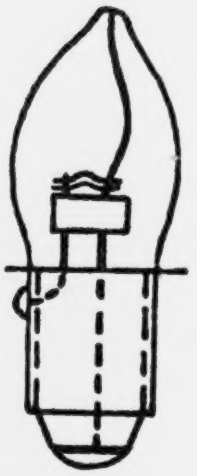

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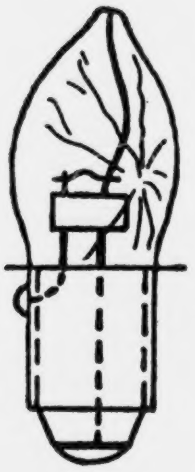

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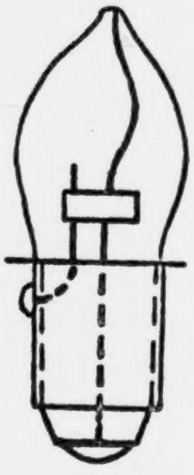

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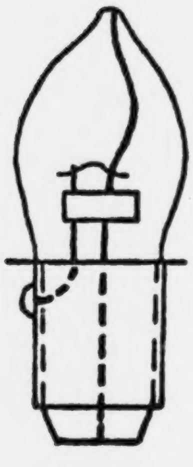

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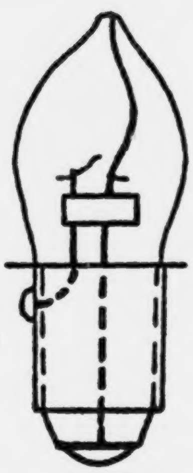

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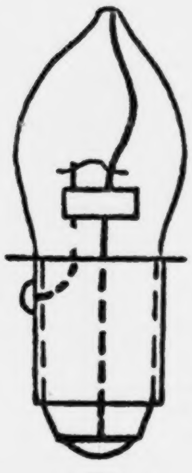

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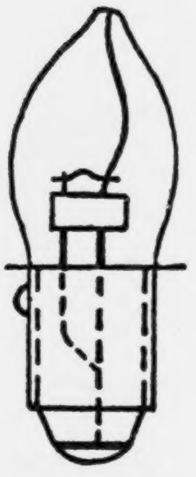

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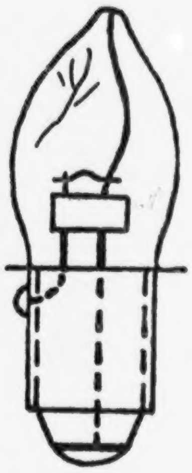
DEFECTIVE FLASHLIGHT BULBS, CONT'D



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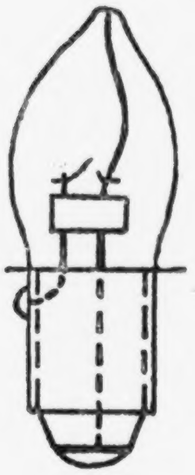

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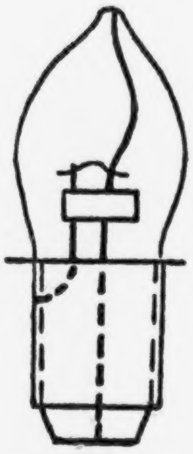

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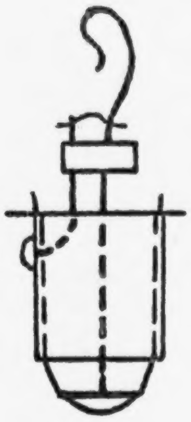

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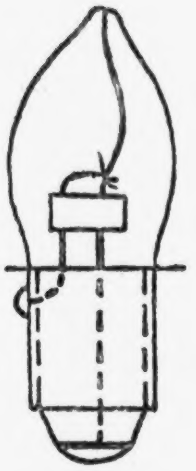

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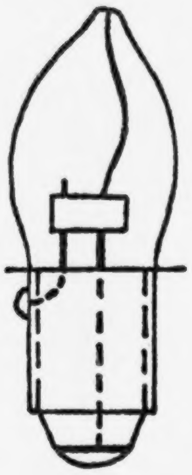

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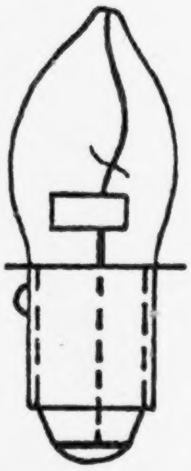

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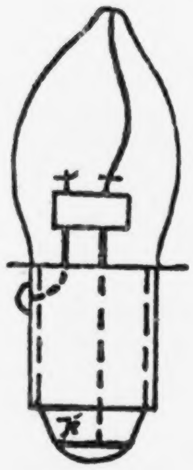

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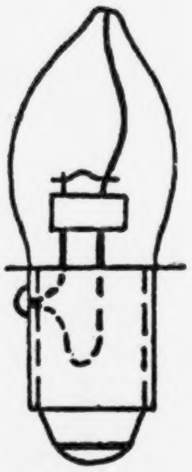

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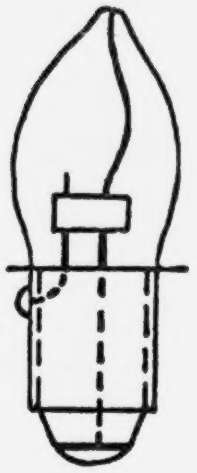
DEFECTIVE FLASHLIGHT BULBS, CONT'D



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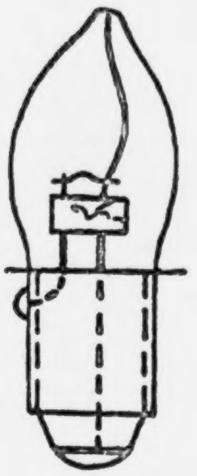

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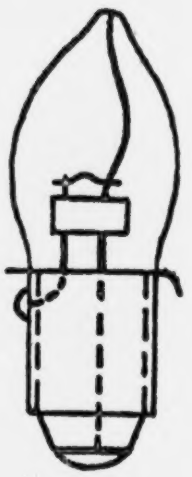

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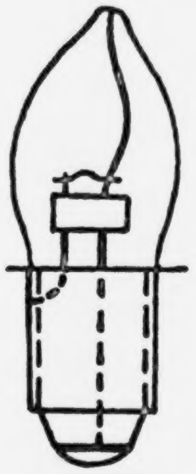

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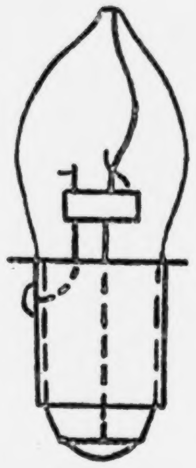

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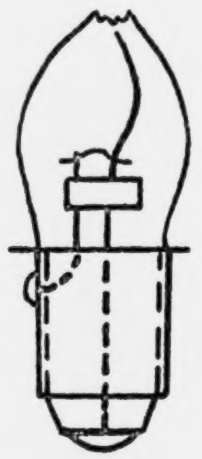

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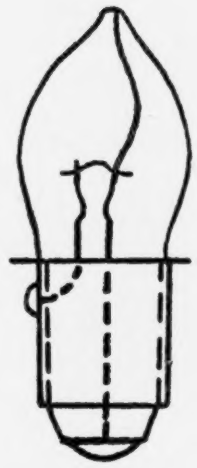

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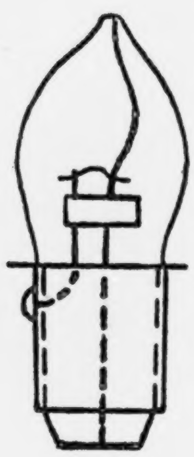

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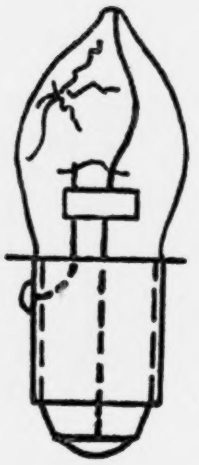

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BULB INSPECTION CHART

Write bulb numbers on the lines that describe bulb condition. For instance, if bulb number 28 had a broken filament and a bent flange, the number 28 would be written on the lines opposite those two defects. More than one bulb number may be written opposite a single defect.

FILAMENT

Broken ________________
Missing ________________
Double ________________

BULB

Broken ________________
Cracked ________________
Broken Tip _______________

LEADS

Broken ____________________
Missing ____________________
Crossed or Tangled ____________________
Bent ____________________
Not Soldered ____________________
Soldered Together ____________________

INSULATORS

Base insulator cracked ___________________
Bridge insulator cracked ___________________
Bridge insulator missing ___________________

FLANGE

Bent ______________

ACTIVITY 5

RAILROADS: PASSENGER SERVICE

SUMMARY

This activity involves relationships between a railroad and the State of California Public Utilities Commission (PUC). The issue being examined by the commission is the request by the railroad to discontinue various passenger services.

In this activity, the students will be placed in the roles of members of the PUC. They will be presented with applications by the railroad for the discontinuance of various passenger trains. Each student will work individually to decide whether the railroad should be allowed to discontinue the trains.

SOLO'S

Each student will correctly correlate specific and general lines of argument in a negotiation between a railroad and a Public Utilities Commission.

MATERIALS

1. A set of Activity 5 student materials for each student
2. Pencils
3. Copy of a PUC pamphlet for the teacher

TEACHER'S GUIDE

1. There are no absolutely correct answers to the cases presented. A student may decide to discontinue all of the trains or none of them. However, he will have to decide upon the relative utility of each train as a public service. His decisions with regard to discontinuing a train should be compatible with the relative priorities that he assigns.

2. Each student is to be given a numerical listing of the general arguments used by the railroad and by the PUC in disputes relating to the discontinuance of passenger trains. As specific arguments are stated in each case, the student is to use numerical designations to show the general argument that each specific argument is based upon.

CALIFORNIA PUBLIC UTILITIES COMMISSION
BROCHURE FOR TEACHER'S REFERENCE

California
PUBLIC UTILITIES COMMISSION

THE COMMISSION

J.P. VUKASIN, Jr.
Chairman

WILLIAM SYMONS, Jr.
THOMAS MORAN
VERNON L. STURGEON
DAVID W. HOLMES
Commissioners

State Building, San Francisco 94102
State Office Building, Los Angeles 90012

Revised February, 1971

ITS HISTORY

The Public Utilities Commission (originally the California Railroad Commission) was created by amendment to the State Constitution in 1911 and implemented by legislation effective in 1912.

This act and subsequent legislation were codified in the Public Utilities Code, effective in 1951. A 1917 law provided for regulation of passenger buses and common carrier trucks, hauling for the public for hire. The Commission was given jurisdiction over additional highway carriers in 1935.

ITS DUTIES

The Public Utilities Commission is charged with regulation of intrastate rates and service of more than 1,500 privately owned utilities and transportation companies serving millions of Californians.

These include gas, electric, telephone, water and steam heat utilities; railroads, buses, trucks, airlines and vessels transporting freight or passengers in intrastate commerce; warehousemen, wharfingers, carloaders and pipeline operators. In addition, more than 17,000 carriers operate for-hire trucks under a permit system.

The Commission does *not* regulate municipally-owned or district-owned utilities or transportation systems, unless ordered by the Legislature, or "mutual" water companies which serve only stockholders or members at cost.

It is the duty of the Commission to secure to the public adequate service at rates that are fair and reasonable, both to customers and shareholders. The law prohibits deviation from authorized rates or discrimination in charges or service.

Subject to certain exceptions, utilities which want to issue stocks or bonds or other securities or sell, transfer, lease or encumber utility property must obtain Commission authorization. Books of account must be kept and annual and other reports must be made as required by the Commission.

MILLIONS OF DOLLARS SAVED

To protect the public interest the Commission appears before federal agencies and courts as an advocate of the interests of Californians in interstate proceedings. Commission action has saved ratepayers of this state many millions of dollars.

Safety is of major concern to the Commission and improved warning signals steadily are being installed at railroad-highway grade crossings. State funds aid cities and counties in paying for better signals, for crossing gates and for overpasses and underpasses, which are paying big dividends in saving lives.

THE COMMISSION

Its Duties . . . How It Functions

The Commission also establishes rules for overhead power lines, for natural gas transmission and storage and for railroad operations.

HOW RATES ARE SET

The charges Californians pay for intrastate transportation and utility service result from rates authorized or permitted by the Public Utilities Commission.

Acting in behalf of the public the Commission holds rates and fares at the lowest levels which will enable utilities to earn "just and reasonable" returns on their investments. The United States Supreme Court has ruled that a public utility is constitutionally entitled to an opportunity to earn a reasonable return upon its investment which is lawfully devoted to the public use.

Present rates, having been so established, are presumed to be fair and reasonable. If an application for an increase in rates or fares is filed, the burden of proof always is upon the applicant to show that additional revenue is necessary to provide a fair and reasonable return. Except in minor cases public hearing is held.

PUBLIC HEARINGS HELD

After an application for a rate increase is filed with the Commission, a public hearing is scheduled and announced so that everyone interested may attend. Hearings, in a major case, may require several days, extending over a period of weeks, with intervals between, if necessary, to allow all interested parties time to study exhibits and testimony presented and to prepare cross-examination and their own testimony.

The applicant first states the reasons an upward adjustment in rates is requested. Company officials testify under oath, at a public hearing which anyone may attend, as to the utility's investment, its actual and requested earnings, its revenues and operating costs. These witnesses may be cross-examined by public representatives and by a Commission attorney, acting in the public interest. Commission staff experts challenge any statement or company claim they do not believe to be accurate or justified, and may present evidence on all issues.

The contents of this brochure constitute a very general statement of the duties and procedures of the Public Utilities Commission and are not to be construed as exhaustive of any of the subjects discussed.

IF YOU HAVE A QUESTION . . . OR A COMPLAINT

The Commission and its staff are always ready to give the public all available information on regulation of public utilities and transportation companies under its jurisdiction. They operate under tariffs and rules which are on file with the Commission and also are open to public inspection at company offices.

The company should first be asked for information on rules, service, rates or fares. Most questions will be answered and most complaints satisfactorily settled. If not, the Commission staff upon request will investigate promptly, taking the matter up with the company and attempting to arrive at a reasonable adjustment of the matter.

Employees of the Commission assigned to receive and to take action on complaints give the most courteous attention to all requests. They will make every effort to speed investigation and to obtain prompt correction of any service found to be inadequate.

If the Commission staff is unable to obtain satisfactory adjustment, the complainant may file a formal complaint, naming the utility as defendant. Usually this results in a public hearing, with sworn testimony, and a formal Commission order deciding the issues. The burden of proof in such a case rests upon complainant.

DISPUTED UTILITY BILLS

If a customer questions the amount of a utility bill, he should ask the company for an explanation. If he still believes the bill is incorrect, he may informally complain to the Commission. The Commission will then investigate the matter thoroughly, and direct a refund of any excess charge to the customer.

WHERE TO GET INFORMATION

In Northern California, Fifth floor, State Building, McAllister and Larkin Streets, San Francisco 94102. Telephone (415) 557-0647. Address letters to California Public Utilities Commission.

In Southern California, Room 5109, State Office Building, 107 South Broadway, Los Angeles 90012. Telephone (213) 620-2564. Address letters to California Public Utilities Commission.

Additionally, Commission field offices are located in 14 cities: Bakersfield, El Centro, Eureka, Fresno, Oakland, Redding, Sacramento, San Bernardino, San Diego, San Jose, Santa Ana, Santa Barbara, Santa Rosa and Stockton.

WHAT'S THE ANSWER?

Here are some of the most common questions asked, and the answers, which may explain what you have wanted to know about the Public Utilities Commission or the rates, rules or service of a utility.

Q. Are Commission records public?

A. All applications and formal complaints which are filed and the information they contain are matters of public record and may be inspected by the public. All annual reports of utilities are available to the public in both the San Francisco and Los Angeles offices of the Commission. Exhibits and evidence presented at public hearings, letters which have been made a part of the record in any case, the transcript of testimony and the Commission's decision in the proceeding are matters of public record and are open to inspection.

Q. Upon what basis may a public utility seek an increase in rates?

A. Regulated utilities provide service at rates established after public hearings and study of all factors by the Public Utilities Commission. Afterward, any major additional expense such as higher taxes or increased wages, would tend to reduce the earnings of a company, perhaps below the amount found to be just and reasonable. According to law, if that occurs, the utility is justified in filing an application for higher rates.

In an inflationary period utilities and transportation companies may face rising costs which reduce their net income. Inflation, in such instances, is the real reason rates and fares have risen.

Q. Does the Commission allow political donations and social club dues as chargeable operating expenses in determining rates and fares of regulated companies?

A. No. For rate-making consideration such expenditures are not chargeable as operating expenses. They must be paid for out of net return, by shareholders and not by customers.

Q. Why are minimum rates established for truck carriers who haul for the public for hire under permits? Why are they not allowed to charge as low a rate as they wish?

A. State law provides that minimum rates are to be established when necessary and that rates shall not be discriminatory. Before enactment of the Highway Carriers Act, rate cutting was common and many truck operators went bankrupt or quit operating because they were unable to earn as much as their costs of operation. The public suffered because continued rate cutting brought chaos to the trucking industry and this meant uncertain and undependable service. Rates were discriminatory and unstable, with higher rates for some shippers and lower rates for others.

IF YOU HAVE A QUESTION ... OR A COMPLAINT

The Commission and its staff are always ready to give the public all available information on regulation of public utilities and transportation companies under its jurisdiction. They operate under tariffs and rules which are on file with the Commission and also are open to public inspection at company offices.

The company should first be asked for information on rules, service, rates or fares. Most questions will be answered and most complaints satisfactorily settled. If not, the Commission staff upon request will investigate promptly, taking the matter up with the company and attempting to arrive at a reasonable adjustment of the matter.

Employees of the Commission assigned to receive and to take action on complaints give the most courteous attention to all requests. They will make every effort to speed investigation and to obtain prompt correction of any service found to be inadequate.

If the Commission staff is unable to obtain satisfactory adjustment, the complainant may file a formal complaint, naming the utility as defendant. Usually this results in a public hearing, with sworn testimony, and a formal Commission order deciding the issues. The burden of proof in such a case rests upon complainant.

DISPUTED UTILITY BILLS

If a customer questions the amount of a utility bill, he should ask the company for an explanation. If he still believes the bill is incorrect, he may informally complain to the Commission. The Commission will then investigate the matter thoroughly, and direct a refund of any excess charge to the customer.

WHERE TO GET INFORMATION

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(Name)

THREE CASES BEFORE THE PUBLIC UTILITIES COMMISSION

Case 1 - The railroad is asking for permission to discontinue a day train called the COMET that travels between San Francisco and Los Angeles.

Case 2 - The railroad is asking for permission to discontinue a night train called the PLANET that travels between San Francisco and Los Angeles.

Case 3 - The railroad is asking for permission to discontinue a day train called the SATELLITE that travels between San Francisco and Monterey.

1. Separate the pages of Activity 5 into three piles, as shown in the sketch on the next page.
2. Read pages 1, 2, and 3 to find out what you are to do.
3. Read the pages titled "Discussion Between Railroad and P.U.C."
4. Look over the page titled "Arguments For and Against the Passenger Trains."
5. Your first task is this: For each statement on pages 4, 5, and 6 find the argument number (such as P1, P4, R3, etc.) on p. 3 that fits the statement, and write it in the space next to the statement. Do this for all 15 statements. Each statement is based on an argument. Your job is to find the argument behind the statement.
6. One of the railroad's arguments and one of the P.U.C.'s arguments sound like the question of, "Which came first, the chicken or the egg ?"

   Which two arguments sound like that ? (Write in the code numbers of the arguments:

Railroad's argument ☐

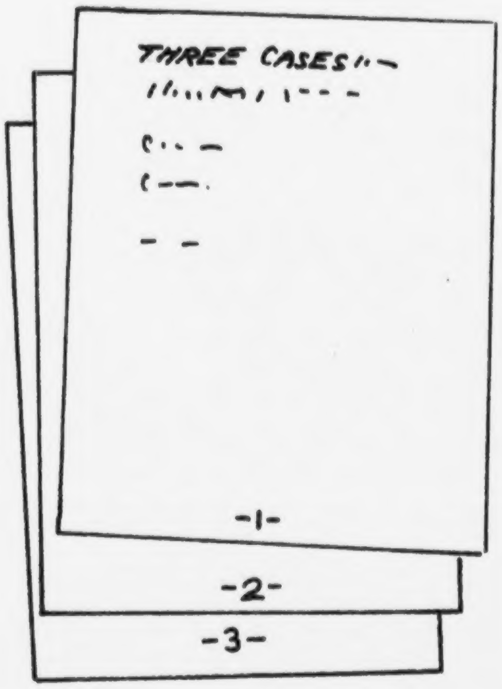
P.U.C.'s argument ☐

CONTINUE ANSWERING THE QUESTIONS ON P. 3

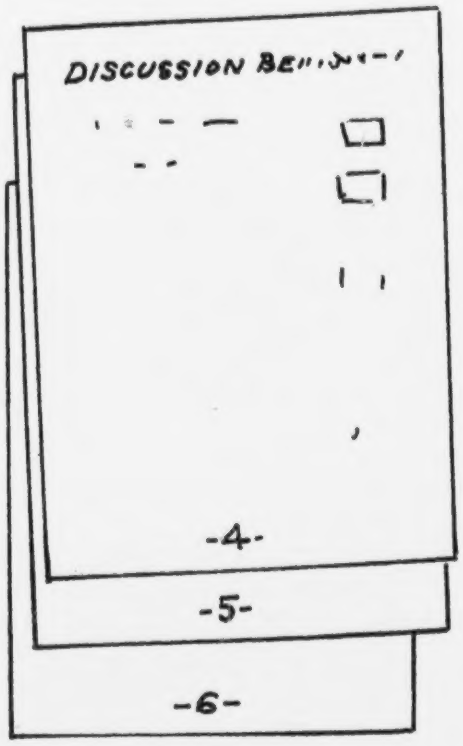
PAGE SET-UP

Read these pages for instructions.

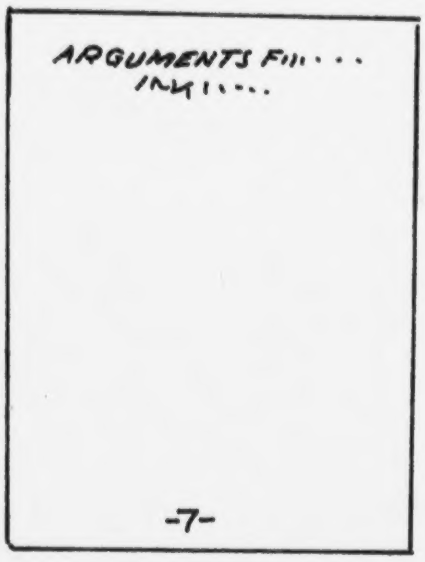
Also, write your findings in the appropriate places.



Read these pages to learn the points of view of the railroad and the P.U.C.



Read these pages to learn the summarized arguments of the railroad and P.U.C.



5. Which of the three trains do you think is the most useful to the public?

____

6. Which of the three trains do you think is the least useful to the public?

____

7. As a member of the P.U.C., trying to protect the public and trying to be fair to the railroad, what would you decide in each case? (Check 1 square for each case.)

Case 1: COMET	Discontinue	☐
	Keep it running	☐
Case 2: PLANET	Discontinue	☐
	Keep it running	☐
Case 3: SATELLITE	Discontinue	☐
	Keep it running	☐

DISCUSSION BETWEEN RAILROAD AND P.U.C.

RAILROAD: These 3 trains should be discontinued. Hardly anybody rides them any more. ☐ 1

P.U.C.: You haven't been advertising your passenger trains. You don't seem to want the public to ride in them. ☐ 2

RAILROAD: The cost of advertising would be a loss to the railroad because very few people would ride these trains even if we did advertise them. ☐ 3

P.U.C.: It's true that you are getting fewer customers. But more than 16,000 people rode the COMET last year. That is still a fair-sized number of passengers. The rights of those passengers to your service means something. ☐ 4

RAILROAD: Many of those people are riding just a few miles instead of going the whole length of the state. Others are school children riding at half fare. ☐ 5

P.U.C.: Those people must find the service useful. ☐ 6

RAILROAD: Yes, but we are operating at a loss. ☐ 7

P.U.C.: That loss is small in comparison with railroad profits on the shipment of goods. ☐ 8

RAILROAD: Let's consider something else. People are using airlines and buses, and they get where they are going more quickly and conveniently. ☐ 9

P.U.C.: Not always. Passengers coming from Monterey to San Francisco get good service from the SATELLITE. Also, they don't have to worry about getting to the Monterey Airport or about getting back and forth between San Francisco and the San Francisco Airport. ☐ 10

RAILROAD: The passengers on the SATELLITE have dropped from a total of 120 a day twenty years ago to only 50 a day now. ☐ 11

P.U.C.: If the trains and stations were kept in better condition, more people would use them. ☐ 12

RAILROAD: If more people would use them, we could keep them in better condition. ☐ 13

P.U.C.: Another point is this: The SATELLITE is the only passenger train running between San Francisco and Monterey and the PLANET and the COMET are the last passenger trains between San Francisco and Los Angeles. The PUC does not want to see the last link broken. The Monterey train and at least one of the 2 San Francisco-Los Angeles trains should keep running. ☐ 14

RAILROAD: The drop in the COMET and PLANET passenger lists is even worse than for the SATELLITE. The COMET has dropped from 450 passengers a day to 150 a day over the past 20 years. And the PLANET has gone all the way from 400 a day down to 40 because hardly anybody rides in pullmans any more.

15

ARGUMENTS FOR AND AGAINST THE PASSENGER TRAINS

ARGUMENTS BY THE PUBLIC UTILITIES COMMISSION	ARGUMENTS BY THE RAILROAD
P 1 Enough passengers use the train to make it a worthwhile public service.	R 1 Very few passengers still use the train.
P 2 Less people use the train because the railroad does not spend money to make the train attractive to passengers.	R 2 The railroad cannot afford to spend money trying to attract people to a train that few people will use.
P 3 The other means of transportation between the cities in question are not always convenient to use.	R 3 There are other good means of transportation between the cities in question.
P 4 The amount of money lost is very small compared with the railroad's income on freight.	R 4 The railroad is losing money by operating the train.
P 5 It is important to keep the last passenger train running between 2 cities after all others have been discontinued.	R 5 Many of the passengers are not making long trips or paying full fares.

Activity 13

SEWAGE TREATMENT PLANT STUDY

SUMMARY

This activity places students in the roles of analysts studying the operations of a sewage disposal plant. Students read descriptive material and place symbolic figures on a chart which depicts the flow of operation in a sewage treatment plant. The relationship of sewage to government operation is in the need for certain municipal personnel to understand the operations of city and county operated facilities.

SOLO

The student will assemble the "Sewage Flow Diagram" applying symbolic coding, and will make at least 16 correct placements out of 20.

MATERIALS

1. A Student Activity 13 for each student.
2. Twenty-five straight pins for each student. (Includes five additional pins to account for possible loss.)
3. A pair of scissors for each student.

TEACHER'S GUIDE

1. In this activity, the student uses two guides: The printed "Sewage Treatment" and the pictorial "Sewage Flow Diagram." After separating the twenty "Sewage Insets" with a pair of scissors, the student follows both "guides" and pins the insets onto the correct corresponding squares of the "Sewage Flow Diagram." The teacher checks the student's completed diagram against the Key to verify that it is correctly assembled.

2. This seemingly abstract exercise is solvable by the students through application of "Gestalt" methods. The symbology used in the coding is pictorial and dramatized. Also, there is a geometry involving right-angle turns and other geometric clues that provide subtle guidance. With these aids, the student's understanding of the sewage treatment process need not be highly analytic.

3. Give the students a brief description of sewage plant operation, using the Teacher's Key and student materials as information sources. Explain their roles as government analysts of sewage plant operations.

4. Tell the students to cut out the 20 "Sewage Insets" and place them correctly on the "Sewage Flow Diagram," pinning them in place as soon as they are reasonably sure of each inset's position.

5. Encourage the students to check back and forth between the "Sewage Treatment" description and the "Sewage Flow Diagram" as they work, in order to find position clues.

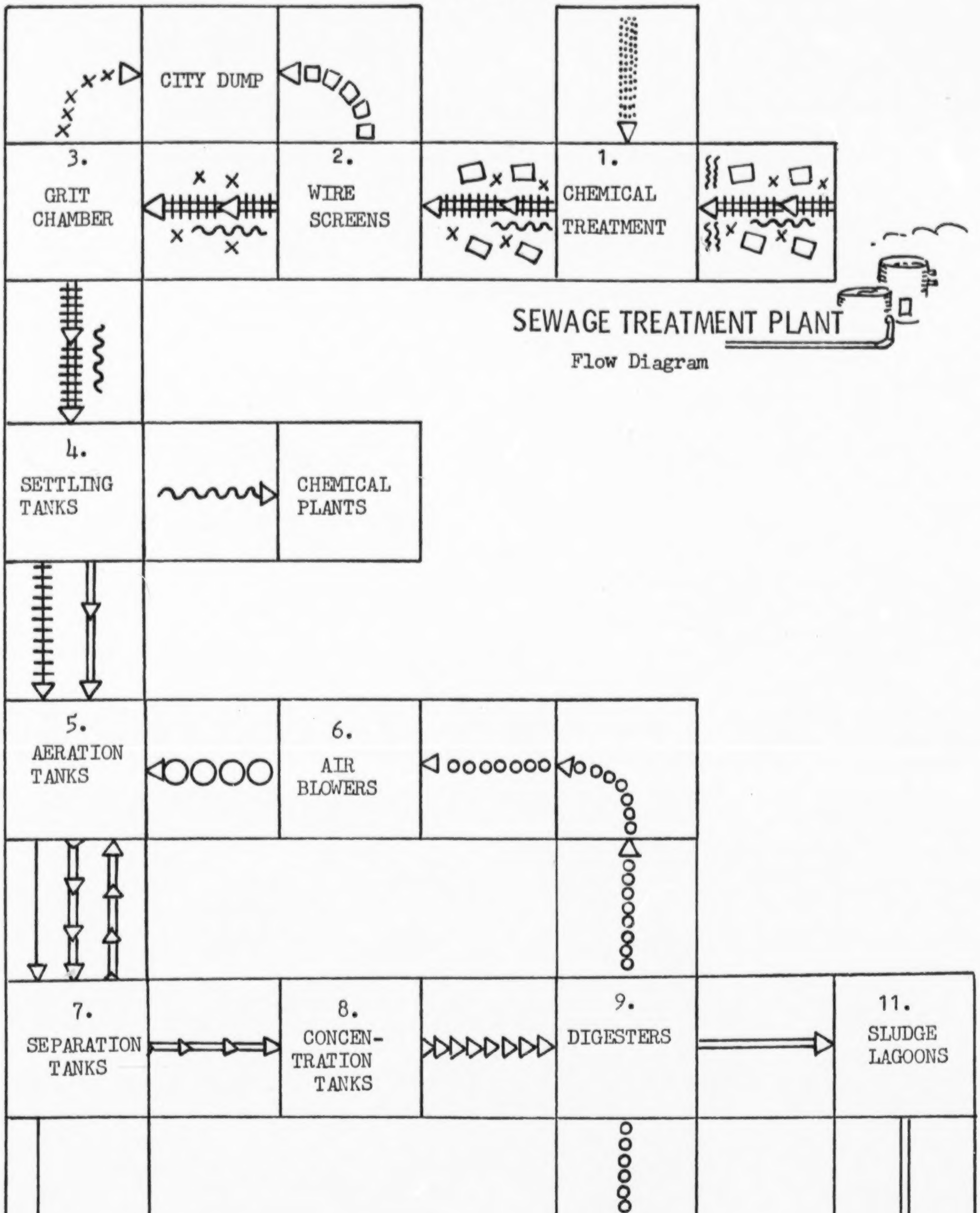
6. Also encourage the students to try various placements to see how they work, changing them as necessary.

7. Circulate among the students and check SOLO accomplishment by direct observation.

TEACHER'S KEY

SEWAGE TREATMENT PLANT

Flow Diagram



Unit 3

____
(Name)

Activity 13

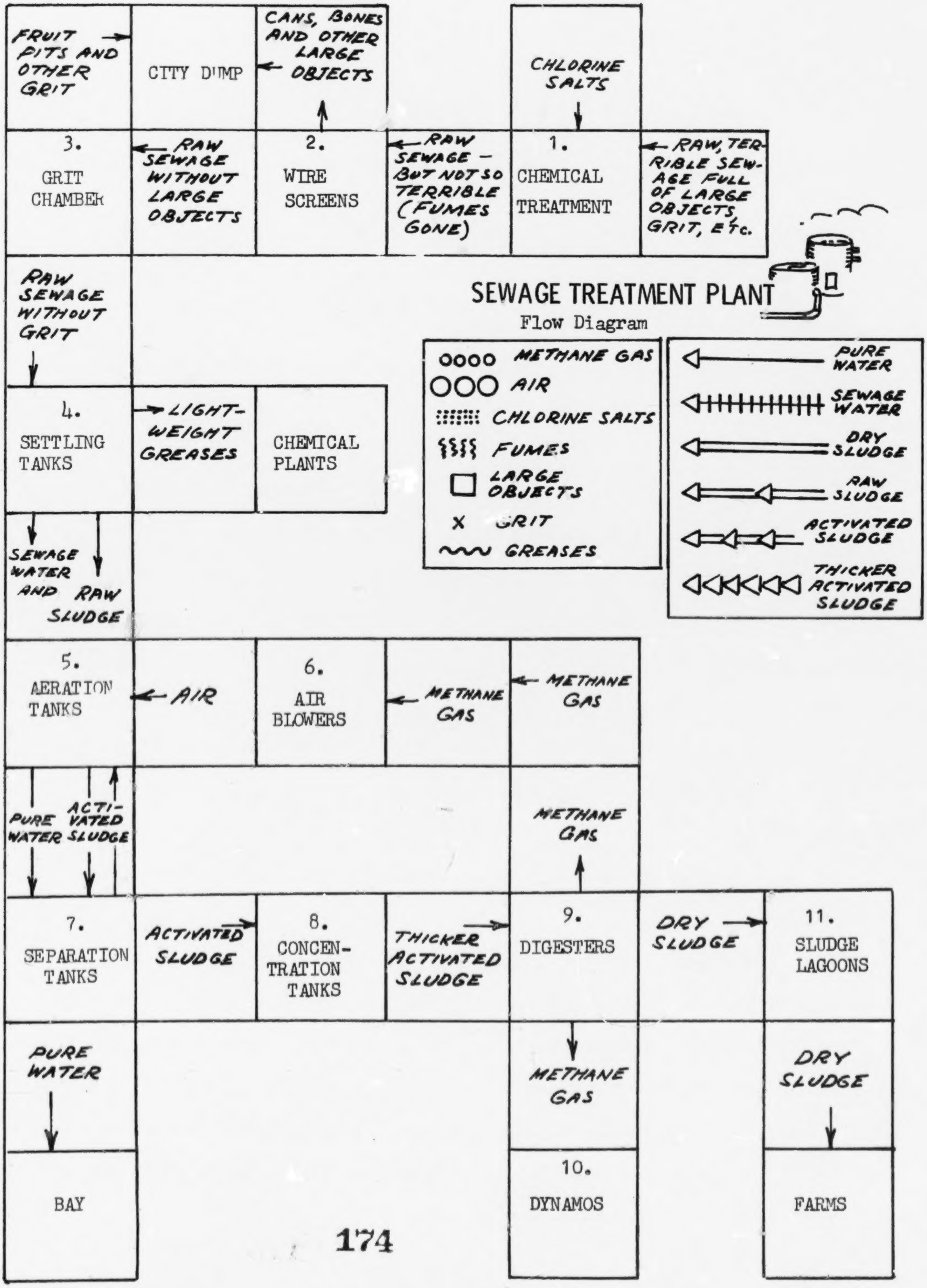
SEWAGE TREATMENT

READ THESE INSTRUCTIONS BEFORE YOU ATTEMPT TO SOLVE THE "SEWAGE FLOW DIAGRAM.'

1. Chlorine salts are added to the raw sewage.
2. The sewage goes through wire screens so that large objects such as cans, bones, etc. can be screened out.
3. The sewage enters the GRIT CHAMBERS where grit, such as fruit pits, is taken out of the sewage by a whirling process.
4. The sewage goes into SETTLING TANKS where a thick sludge settles to the bottom. Lighter material and grease float to the top and are skimmed off. Sludge and sewer water are left.
5. The sludge and sewage water enter the AERATION TANKS. There, air blowers (No. 6) force air into the sludge. The air bubbles "activate the sludge," so that bacteria in the sludge are able to digest sewage very quickly, leaving the water purified.
7. The activated sludge and the purified water are pumped into the SEPARATION TANKS. There they are separated, and the purified water flows into the bay.
8. The activated sludge is pumped into the CONCENTRATION TANKS where it is thickened.
9. Then, the activated sludge is pumped into the DIGESTERS where the sludge digests itself. Methane gas given off in the digesters is piped out as fuel for the AIR BLOWERS (No. 6) and the DYNAMO (No. 10) that supplies electrical power for the plant.
10. The dry, digested sludge is taken from the digesters by trucks that unload it in the SLUDGE LAGOONS. From there, the dry sludge is taken away to be used as fertilizer on farms.

SEWAGE TREATMENT PLANT

Flow Diagram

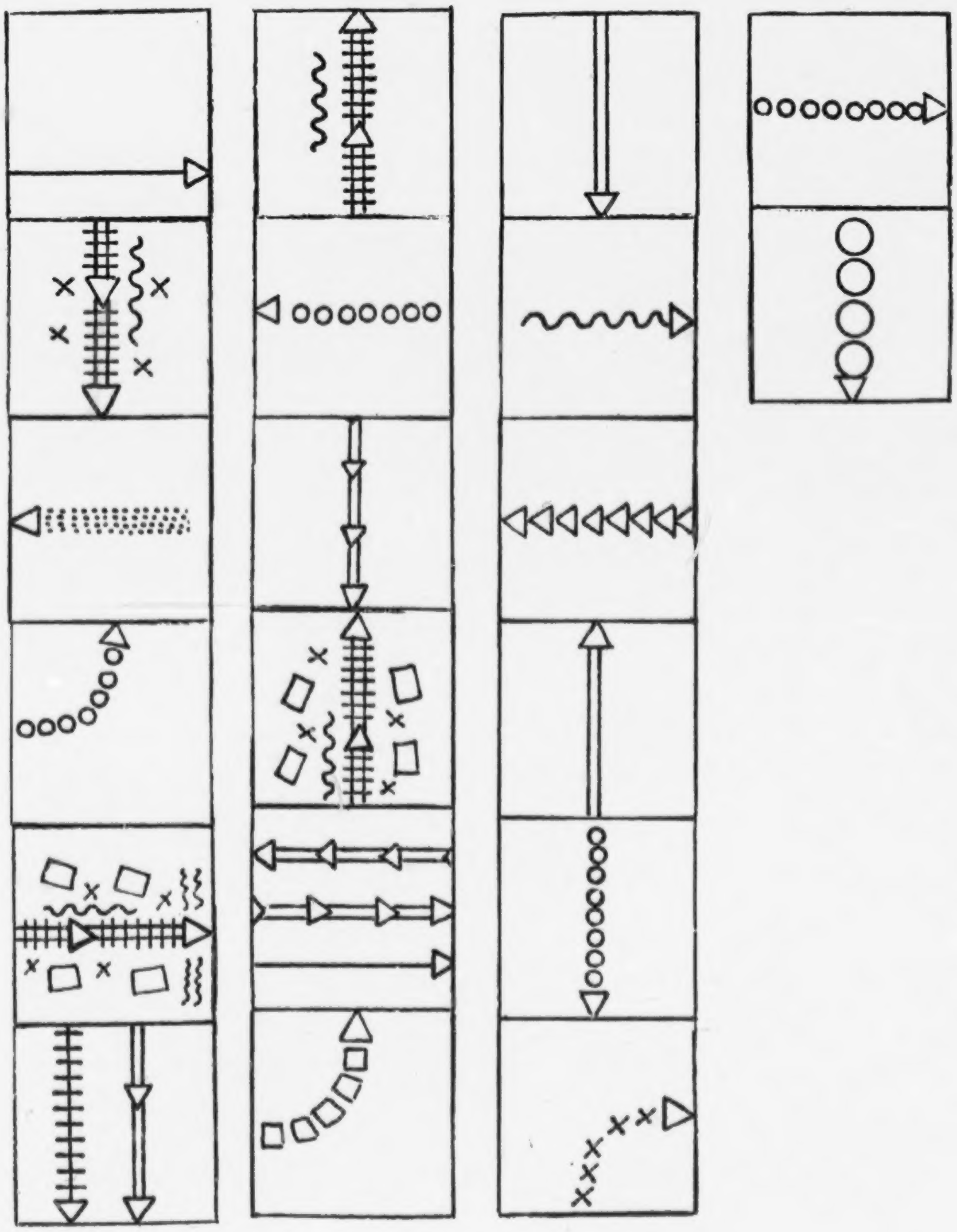


INSETS
FOR
SEWAGE TREATMENT PLANT STUDY

Instructions:

1. Cut out the 20 Insets with a pair of scissors.
2. Read p. 1 ("Sewage Treatment") of your Student Activity.
3. Use pins to attach the Sewage Insets to the diagram titled "Sewage Treatment Plant" (p. 2 of your Student Activity).

SEWAGE INSETS



Activity 3
THE RINGELMANN CHART

SUMMARY

This activity begins with a short explanation by the teacher of the need for accurate measurement in determining amount of pollutants entering the atmosphere. The teacher explains the background and use of the Ringelmann Smoke Chart, which has common acceptance as a standard for determining the degree of unburned particles in smoke columns. The teacher explains how the chart is used and assigns students (either individually or in teams) to make comparisons of "simulated smoke samples" (cardboard placards or sheets of paper of varying degrees of grayness) with the Ringelmann scale. Students enter their data onto special forms, and, following a completed example, determine a "percentage smoke density" for the exercise.

SOLO'S

1. The student can observe, compare, and select a Ringelmann Smoke Chart value (within a scale rating of one rating number) when the chart is held below a simulated smoke sample.
2. The student can correctly multiply a two-digit number by a decimal (one place).

MATERIALS

1. Pencils
2. A Student Activity 3 for each student
3. A set (approximately three or four) "simulated smoke samples." These may be placards or paper sheets of varying degrees of grayness (ex., light gray construction paper, reverse side of carbon tracing paper, etc.).
4. A Ringelmann Smoke Chart. These may be obtained from the following source:
   a. U.S. Department of the Interior
      Bureau of Mines
      Box 36012
      450 Golden Gate Avenue
      San Francisco, California 94102

Note: Materials under 3 and 4 are provided as a "kit" (obtain envelope from secretary)

TEACHER'S GUIDE

1. Start the activity by reminding the students that they are learning the techniques used in government operations to study and solve some of the most perplexing problems of our time. Today they will learn how to use a very important tool that is employed in checking air pollution.

2. Begin a discussion on measuring air pollution. Ask the students how local governments decide whether the air on any day is polluted or not. Acknowledge that there are numerous automatic and man-operated pollution monitors that sample and analyze the air. Some of these are capable of counting the number of pollution particles in a million parts of air !

3. Tell the class that in the late 1800's a Professor Ringelmann in France became interested in the problem of smoke coming out of factory smokestacks. He developed a chart (hold up "Ringelmann Smoke Chart") that proved to be quite effective in measuring the amount of unburned material in a column of smoke. By the early 1900's the Ringelmann Chart was in widespread use in the United States and other countries of the world as a means of checking industrial smoke emissions.

4. Hold up the chart or tape it to the chalkboard, and ask for students to volunteer and explain how they think a chart such as this could be used to determine whether a factory is complying with local laws concerning smoke. Encourage the students to think in terms of comparison against a standard.

5. Point out that the grids on the Ringelmann Smoke Chart are numbered. The first grid in titled "1. Equivalent to 20 Percent Black." The last (fourth) grid is titled "4. Equivalent to 80 Percent Black."

6. Tell the class that two grids are missing. Ask them to guess what they would look like and how they would be numbered. Offer the hint that the four grids on the chart are equivalent (define as "same as") 20 percent, 40 percent, 60 percent, and 80 percent black.

7. Tell the class that the two missing grids are for 0 percent black (all white) and 100 percent black (all black). If the Ringelmann Smoke Chart were complete, it would have a white square at the left and a black square on the

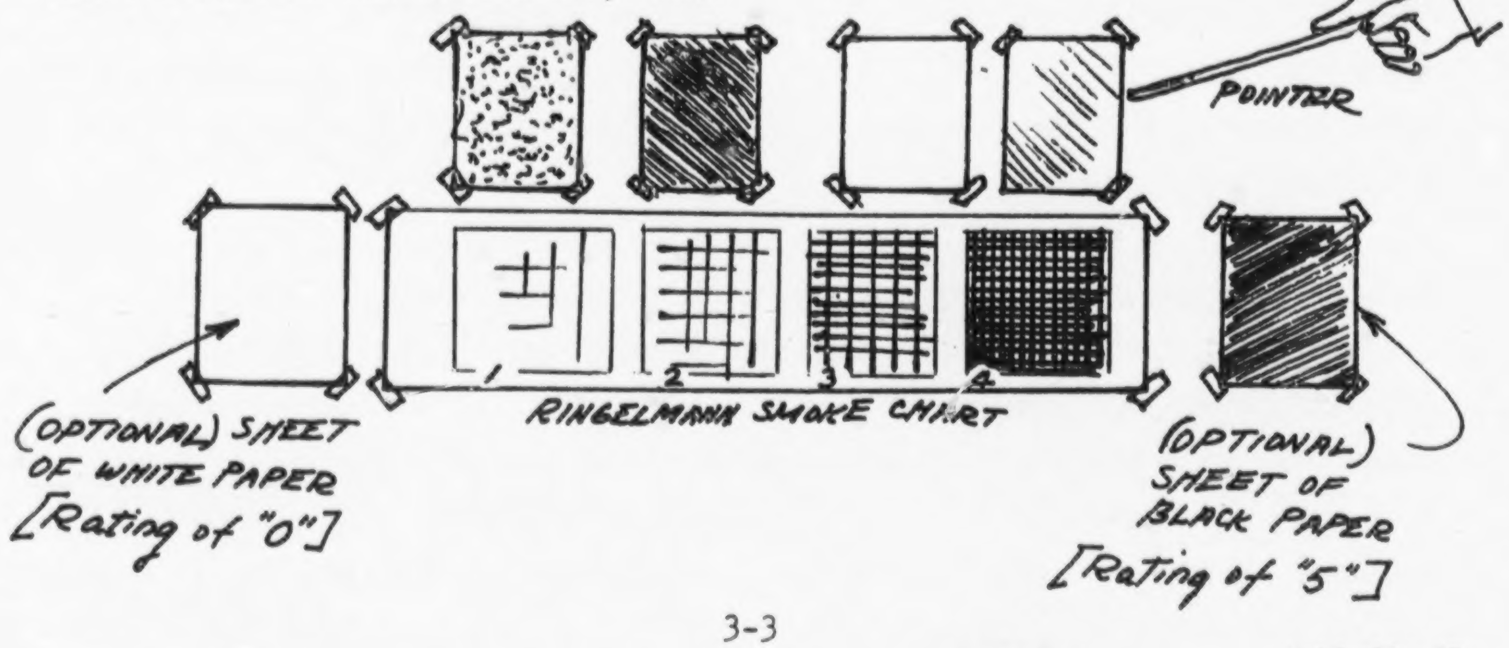
right. The students should imagine that those two grids are on the chart.

8. Explain how the Ringelmann Smoke Chart is used. The chart is held up some distance from the observer's eye (distance may vary) while the observer looks at the column of smoke. The observer may find it convenient to "squint" slightly as he does this. He looks back and forth between the smoke and the chart and tries to match the density (not color) of the smoke with the grids.

9. If the smoke is steam ("pure" white), the observer would give it a rating of 0. If the smoke is dense black, he would rate it 5. The problem arises with in-between shades. If there is only a slight amount of grayness in the smoke, the rating may be only 1. The more unburned particles in the smoke, the denser the smoke, and the higher the Ringelmann rating.

10. At this point it would be ideal to have the students observe columns of smoke issuing from factories or other sources and apply the Ringelmann Smoke Chart. Since this is not practical in all cases, it is necessary to use simulation. For this purpose, the teacher should have on hand a number of cardboard placards or sheets of paper of varying degrees of grayness. (These are provided as part of the "Materials" for this activity.)

11. Distribute a Student Activity 3 to each student. Tell the students to spend a few minutes reading their activity. While they are reading, it will be convenient for the teacher to mount a number of placards and the Ringelmann Chart itself on the chalkboard, thus:


POINTER
1
2
3
4
RINGELMANN SMOKE CHART
(OPTIONAL) SHEET OF WHITE PAPER [Rating of "0"]
(OPTIONAL) SHEET OF BLACK PAPER [Rating of "5"]

The placards above the chart should not be arranged in increasing degree of darkness. Rather, they should be intentionally arranged randomly to make the student's rating exercise more difficult. If it is convenient to do so, the teacher may wish to add sheets of white and all black paper at the extreme ends of the chart.

12. Tell the class that in actual use the observer will look at the smoke over a period of time, perhaps every minute or every 15 minutes and rate it. The reason for this is that if he were to make only one observation, he may be looking at the column before the process producing it was stabilized. By taking a number of observations and averaging them, he arrives at a more accurate figure.

13. Point out that just because a column has a higher rating (say 4 or 5) we cannot automatically say that a law or ordnance is being broken. Quite possibly local laws may permit the issuance of dense smoke for certain short periods of time, or at certain times of the day.

14. The teacher may wish to have the students rate the "simulated smoke samples" individually or as teams. In any event, each student should complete his or her own student activity.

15. As the students view the "simulated smoke samples," some of them may comment on the color. Tell them to ignore color completely and to look only at degree of darkness of shade, endeavoring to reduce all to amounts of gray.

16. Tell the students that their ratings must be whole numbers covered by the Ringelmann scale (0, 1, 2, 3, 4, or 5). If they believe a shade is between two numbers (say 3 and 4), they should pick one or the other number. They should not rate the sample 3.5.

17. Announce that you will point to the smoke samples, one at a time, and the students will decide on the rating and enter it onto their activity forms. It will probably be convenient to have the display at the far end of the classroom, with the students gathered at the other end with their activity forms and pencils. Use a pointer to randomly designate samples they are to rate. Make about ten designations, repeating some.

After the students have obtained their data (made their readings to the best of their ability) have them return to their seats and complete the calculations called for in their student activity.

18. Before the students begin their calculations, spend a few minutes explaining the significance of the "formula" they will use:

$$\frac{\text{Equivalent units of No. 1 smoke} \times 0.20 \times 100}{\text{Number of observations}} = \text{Percentage smoke density}$$

Point out that the observer takes all the readings he has recorded and reduces them to the total equivalent of No. 1 smoke as a standard. Stress the fact that No. 1 smoke is considered as 20 percent dense. The formula contains all the factors needed for averaging all their observations and comparing them with 20 percent dense smoke.

19. Tell the students to begin their calculations. Circulate among them and offer assistance where it is needed. Have them refer to the sample solution.

20. Students who finish early should be assigned a writing exercise (example, "How the Ringelmann Smoke Chart is Used") to keep them challenged until a significant number of students have completed their calculations. When most of the class has finished their calculations, ask them to volunteer the values they have found. Write them on the chalkboard. If most of the students used approximately the same "standards" of estimating, the values should be close to each other. Ask the students to comment on this.

21. Collect the student materials, and evaluate them for SOLO accomplishment.

____
Name(s)

RINGELMANN CHART READINGS

Instructions:

1. Record your smoke observation ratings here:

Observation No.	Ringelmann Scale No. (0, 1, 2, 3, 4, or 5)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

2. Now, reduce the data in your table to Equivalent No. 1 Smoke Units, since your answer (Percentage smoke density) will be found by this formula:

$$\frac{\text{Equivalent units of No. 1 smoke} \times 0.20 \times 100}{\text{Number of observations}} = \text{Percentage smoke density}$$

Fill in the data in column A. Then multiply each number in column A by the smoke rating alongside it. Write the product in column C. (See the accompanying "Sample Ringelmann Chart Readings" sheet to see how this is done.)

A	B	C
Units (No. of Observations)	Rating	Equivalent No. 1 Smoke Units
	No. 0 Smoke	
	No. 1 Smoke	
	No. 2 Smoke	
	No. 3 Smoke	
	No. 4 Smoke	
	No. 5 Smoke	

Show your calculations here:

_____ Total Units

_____ Total Equivalent units of No. 1 smoke

3. Use the formula, and write your answer here | = Percentage smoke density |

Name(s)

SAMPLE
RINGELMANN CHART READINGS

Instructions:

1. Record your smoke observation ratings here:

Observation No.	Ringelmann Scale No. (0, 1, 2, 3, 4, or 5)
1	4
2	3
3	3
4	4
5	1
6	0
7	5
8	3
9	2
10	5

2. Now, reduce the data in your table to Equivalent No. 1 Smoke Units, since your answer (Percentage smoke density) will be found by this formula:

$$\frac{\text{Equivalent units of No. 1 smoke} \times 0.20 \times 100}{\text{Number of observations}} = \text{Percentage smoke density}$$

Fill in the data in column A. Then multiply each number in column A by the smoke rating alongside it. Write the product in column C. (See the accompanying "Sample Ringelmann Chart Readings" sheet to see how this is done.)

A	B	C
Units (No. of Observations)	Rating	Equivalent No. 1 Smoke Units
1	No. 0 Smoke	1×0 = 0
1	No. 1 Smoke	1×1 = 1
1	No. 2 Smoke	1×2 = 2
3	No. 3 Smoke	3×3 = 9
2	No. 4 Smoke	2×4 = 8
2	No. 5 Smoke	2×5 = 10

Show your calculations here:

$$\frac{30 \times 0.20 \times \overset{10}{\cancel{100}}}{\underset{1}{\cancel{10}}} = 60$$

$$\begin{array}{r} 0.20 \\ \times\ 10 \\ \hline 02.00 \end{array} \text{ or } 2$$

$2 \times 30 = 60$

10 Total Units

30 Total Equivalent units of No. 1 smoke

3. Use the formula, and write your answer here **60 = Percentage smoke density**

Activity 4/5

CAR COUNT AND POLLUTION FORECAST

SUMMARY

This two-day activity places students in the roles of citizens who have volunteered to help their community obtain pollution forecast data. After a brief introduction by the teacher into the problem's background, the students are given printed outlines which they read and refer to (on their own) to further illuminate an approach to solving the problem. They sketch out an approach, and then are grouped in pairs or trios to discuss their approaches further and modify them if necessary. One or two groups are asked to present their approach orally to the class, and comments are solcited. Following this, the students are given structured solution sheets, which they read before making the vehicle count. The vehicle count is made for 15 minutes on a nearby street. The students return to class with their data, which they use for arriving at their estimates. The activity concludes with a comparison of calculated values and an evaluation of errors that may have been made.

SOLO'S

1. Given an outlined solution to a "Pollution Forecast," the student will produce in writing a reasonable approach to obtaining a numerical answer.
2. The student can correctly input vehicle count data into an outlined "Method for Forecasting Pollution" and correctly peform the associated arithmetic operations.

MATERIALS

1. Pencils
2. A Student Activity 4 for each student (distributed on first day of activity)
3. A "Method for Forecasting Pollution" for each student (distributed after the students have completed their Student Activity 4)
4. A (student's own) wristwatch for each two or three students (used to time 15-minute vehicle counting interval on second day of activity)

TEACHER'S GUIDE

1. This is a two-day activity that simulates a task that is routinely carried out by communities, usually to obtain traffic data. In this case, students carry the vehicle count data further and estimate the quantity of pollution produced in a particular area. The activity stresses reading and interpreting written instructions and carrying out arithmetic calculations.

2. Begin the activity by telling the students they will engage in a simulation that is highly important in governmental operations. Tell them that while air pollution is being attacked on many fronts, it is still a matter of controversy in some places as to how much pollution is being produced.

3. Tell the class they will be in the roles of citizens who have volunteered to estimate the amount of pollution being produced by cars in a certain part of town. Each pair or trio of students will actually count cars on Naglee Avenue and follow a procedure for estimating the number of pounds of pollution produced by the cars over a one mile distance in one hour.

4. Hand out a Student Activity 4 to each student. Tell the students to read the information on their activity and to raise their hand if they have questions. The teacher may wish to review the essential points covered on the Student Activity.

5. Stress the fact that there is an important reason for obtaining the pollution estimates. The city is going to purchase a machine to monitor pollution automatically. Before the machine can be built, however, the manufacturers' engineers must have at least a rough idea of the amount of pollution the machine must handle. The citizens (groups) will obtain this information by direct investigation.

6. Before the students are placed in pairs or trios, they should be assigned the task of studying the information on their Activity and endeavoring to "sketch out" a way of finding the desired information. Tell the students to think in terms of a one-mile stretch of road, with many vehicles traveling in both directions for one hour. Automobiles use up a certain amount of gasoline in covering the one-mile; trucks and buses use up a larger amount of gasoline to cover the same distance.

7. Tell the students to choose an arbitray number of cars that would pass through the one-mile distance for an hour, and to estimate how much gas they would use. Point out that their Student Activity contains information on gas mileage, gasoline weight, and percentage of gasoline that ends up as pollution.

8. After the students have spent a few minutes trying to organize an method of attack, pair them (or place them in trios) as groups who will work throughout Activity 4/5. Preferably have a high achiever or average achiever with a low achiever. Tell the groups to "pool" their thinking and map out an approach for obtaining the vehicle count data and producing the required information (ultimately, number of pounds of pollution produced by all vehicles traveling over a mile in one hour).

9. After the pairs and trios have had some time to come to agreement as to method of attack, ask for volunteers to describe how they plan to obtain the data and produce the required answer.

10. Preferably allow one group to comment on another's approach in the interest of stimulating debate.

11. If none of the groups wishes to volunteer or, alternatively, after one or more has spoken on its approach, hand out a "Method for Forecasting Pollution" to each student. Have the students read them on their own. When they finish reading, each group is to discuss among themselves how they will employ the "method" about which they have just read.

12. The outcome of this discussion must produce an understanding in each group as to how they will actually position themselves on Naglee Avenue and how they will count cars and larger vehicles, taking into account that Naglee is a two-way street. The teacher may wish to question students to assure himself or herself that the students are ready for the car-counting exercise to follow.

13. It is advisable to have this part of the activity end on the first day. Materials should be collected, evaluated for SOLO accomplishment, and stored until they are needed on the second part of the activity.

DAY 2

14. The students should be reminded that they are involved in a simulation of a real-life activity in which citizens are participating to assist their local government to obtain important data on air pollution.

15. Return the Student Activities completed the preceding day, and conduct the groups (pairs and trios) to Naglee Avenue. Caution the students against standing too close to the curb. Tell them not to make any gestures or movements that might distract drivers.

16. Make sure that each pair or trio of students has a watch. A second hand is not necessary, since data will be accurate to the nearest minute.

17. Ascertain that the students are in safe positions, and tell them to begin counting vehicles for 15 minutes whenever they are ready. Keep close watch over the operation at all times to be sure that students do not absent-mindedly move to unsafe locations.

18. At the end of the 15-minute period, conduct the groups back to class.

19. Have the students complete their calculations, using the vehicle count data they have just obtained. As students begin to produce their answers, have the groups report them, and write them on the chalkboard. Look for values that diverge widely. Use this divergence as an indicator of an incorrectly carried out step.

20. Conclude the activity with a discussion aimed at bringing out the citizen's dependency on mathematical and reading skills to solve critical social problems.

21. Collect all student materials and evaluate them for SOLO accomplishment.

METHOD FOR FORECASING POLLUTION

TEACHER'S EXAMPLE

____
(Name)

Instructions:

1. Read the following "Method for Forecasting Pollution."
2. Compare this method with the one you and your associates have worked out.
3. Then decide on the way you will collect data and make your estimate.

A. Station yourself on Naglee Avenue with your associate.

B. Since Naglee Avenue is a two-way street, you may wish to stand on different sides of the street to count cars.

C. One of you should have a watch with a second hand.

D. On a pre-arranged signal, both of you should start to count vehicles.

E. You should count automobiles and other (larger) vehicles separately. STAND FAR BACK FROM THE CURB FOR SAFETY REASONS.

F. Decide on the way you wish to keep count. You may wish to place a line on your Tally Sheet each time a car goes by, or you may wish to use a different method.

G. Count vehicles for a total of 15 minutes, over a 1-mile distance.

H. Return to the classroom with your vehicle count data.

I. Calculate the amount of gasoline used by both cars and larger vehicles (do not count motorcycles).

* No. cars (moving in both directions) x 4 = No. cars that pass in 60 minutes

* No. larger vehicles (moving in both directions) x 4 = No. of larger vehicles that pass in 60 minutes

* Find the pounds of gasoline used by cars and larger vehicles separately by this method:

CARS — No. Passing in 1 Hour × Gallons of Gas Used by Each Car in 1 Mile × Weight in Lbs of 1 Gallon of Gas

$$\boxed{344} \times \boxed{\tfrac{1}{16}} \times \boxed{6} = C$$

LARGER VEHICLES — No. Passing in 1 Hour × Gallons of Gas Used by Each Larger Vehicle in 1 Mile × Weight in Lbs of 1 Gallon of Gas

$$\boxed{104} \times \boxed{\tfrac{1}{10}} \times \boxed{6} = \underline{L}$$

Total pounds of gasoline used by cars and larger vehicles in 1 mile for 1 hour $\}$ = L + C

J. Multiply L + C by 3%, since that amount ends up as pollution.

TEACHER'S EXAMPLE, CONT.

METHOD FOR FORECASTING POLLUTION
Cont'd

K. The final number (L plus C x 3%) is the amount of pollution in pounds produced by all vehicles in 1 mile for 1 hour.

L. Use this sheet for taking data on cars and larger vehicles.

M. Show all your work on this page.

Count over 15-minutes

Cars

← // 52
////////////

→ ////////////////////////////////// $+34$

86

Larger Vehicles

← ////////////////// 18

→ //////// $+8$

26

Cars passing in 1 hour = $4 \times 86 = \boxed{344}$

Larger Vehicles passing in 1 hour = $4 \times 26 = \boxed{104}$

Gallons of Gas Used by Each Car in 1 Mile: $? \text{ gal} = 1 \cancel{\text{mi.}} \times \frac{1 \text{ gal}}{16 \cancel{\text{mi.}}} = \boxed{\frac{1}{16} \text{ gal.}}$

Gallons of Gas Used by Each Larger Vehicle in 1 Mile: $? \text{ gal} = 1 \cancel{\text{mi.}} \times \frac{1 \text{ gal}}{10 \cancel{\text{mi.}}} = \boxed{\frac{1}{10} \text{ gal.}}$

Weight of Gasoline = $6 \frac{\text{lb}}{\text{gallon}}$

Now, "plug in" numbers:
(From preceding page -a-)

CARS

$$\boxed{344} \times \boxed{\tfrac{1}{16}} \times \boxed{6} = C = 12.9 \text{ lb}$$

$$\frac{344 \times 6}{16} = 12.9$$

LARGER VEHICLES

$$\boxed{104} \times \boxed{\tfrac{1}{10}} \times \boxed{6} = L = 6.24 \text{ lb}$$

$$\frac{104 \times 6}{10} = 6.24$$

L + C } 19.14 lb

Finally, multiply L + C by 3%, since that amountends up as pollution.

$$\begin{array}{r} 19.14 \\ \times\ .03 \\ \hline 0.5742 \end{array}$$

or

$\boxed{\text{0.6 lb is the amount of pollution in pounds produced by all vehicles in 1 mile for 1 hour}}$

____
(Name)

POLLUTION FORECAST

1. Your community is planning to install an automatic monitor to measure pollution caused by vehicles in a certain part of town.

2. The company that will build the monitor must have a rough idea of how much pollution the machine must take in and analyze. A pollution monitor for a freeway would need a much higher capacity than a monitor for a quiet part of town. An estimate is needed on the amount of pollution to be expected.

3. You and one or two fellow citizens have volunteered to help your city make an estimate so that the machine can be ordered.

4. The city has designated that the machine will be installed on Naglee Avenue. It will be necessary for you (along with one or two others) to make a traffic count of vehicles on Naglee Avenue. Then you will have to figure out how to estimate how much pollution the vehicles are putting into the air.

5. Your first job is to get together with the person (or persons) you will be working with and figure out a plan for estimating the amount of pollution released by the vehicles. Before you do this, however:

6. Make the following assumptions:

   a. The pollution monitor will sample air over a distance of 1 mile.

   b. The pollution monitor engineers must know how much pollution will be released over 1 mile in 1 hour. (Assume all cars counted travel 1 mile.)

   c. Cars travel 16 miles to a gallon of gasoline.

   d. Trucks and buses travel 10 miles to a gallon of gasoline.

   e. Gasoline weighs about 6 pounds to a gallon.

   f. About 3 percent of gasoline used ends up as pollution.

7. Spend a few minutes studying this problem on your own. Use the following page to make notes on how you will attack this problem. The method you come up with should have an explanation and one or more simple mathematical formulas that show how the estimate will be made.

METHOD FOR FORECASING POLLUTION

______________________ (Name)

Instructions:

1. Read the following "Method for Forecasting Pollution."
2. Compare this method with the one you and your associates have worked out.
3. Then decide on the way you will collect data and make your estimate.

A. Station yourself on Naglee Avenue with your associate.

B. Since Naglee Avenue is a two-way street, you may wish to stand on different sides of the street to count cars.

C. One of you should have a watch with a second hand.

D. On a pre-arranged signal, both of you should start to count vehicles.

E. You should count automobiles and other (larger) vehicles separately. STAND FAR BACK FROM THE CURB FOR SAFETY REASONS.

F. Decide on the way you wish to keep count. You may wish to place a line on your Tally Sheet each time a car goes by, or you may wish to use a different method.

G. Count vehicles for a total of 15 minutes, over a 1-mile distance.

H. Return to the classroom with your vehicle count data.

I. Calculate the amount of gasoline used by both cars and larger vehicles (do not count motorcycles).

* No. cars (moving in both directions) x 4 = No. cars that pass in 60 minutes

* No. larger vehicles (moving in both directions) x 4 = No. of larger vehicles that pass in 60 minutes

* Find the pounds of gasoline used by cars and larger vehicles separately by this method:

CARS	No. Passing in 1 Hour		Gallons of Gas Used by Each Car in 1 Mile		Weight in Lbs of 1 Gallon of Gas	
	☐	×	☐	×	☐	= C
LARGER VEHICLES	No. Passing in 1 Hour		Gallons of Gas Used by Each Larger Vehicle in 1 Mile		Weight in Lbs of 1 Gallon of Gas	
	☐	×	☐	×	☐	= L

Total pounds of gasoline used by cars and larger vehicles in 1 mile for 1 hour } = L + C

J. Multiply L + C by 3%, since that amount ends up as pollution.

METHOD FOR FORECASTING
POLLUTION
Cont'd

K. The final number (L plus C x 3%) is the amount of pollution in pounds produced by all vehicles in 1 mile for 1 hour.

L. Use this sheet for taking data on cars and larger vehicles.

M. Show all your work on this page.

Activity 10
HURRICANE WARNING GAME

SUMMARY

This activity is a departure from the general theme of measurement and control of air pollution. The emphasis here is on the part that chance plays in the decision-making process. Students are in the roles of community officials who must decide whether or not certain towns should be secured during the hurricane season. The student refers to tabular data on probability and cost of destruction and cost of securing the town. He makes arithmetic calculations, decides, and by rolling dice determines the outcome. A discussion on the treatment of probability in this activity ends it.

SOLO'S

1. The student can make correct decisions on whether or not to secure a town in the "Hurricane Warning Game" by comparing the cost of securing with the probable saving.
2. The student can correctly multiply a 4-digit number by a 2-digit number.
3. The student can correctly subtract a 5-digit number from a 6-digit number.

MATERIALS

1. Pencils
2. A Student Activity 10 for each student
3. A pair of dice for each student

TEACHER'S GUIDE

1. Tell the class that this activity is a departure from the preceding ones of the unit which dealt with air pollution. Tell the students that although the subject here has something to do with air (i.e., the atmosphere), the emphasis is on decisions that must be made because of the possibility of a hurricane causing damage to towns.

2. Stress the fact the preceding activities dealt with the gathering of "hard" data by deliberate methods. Point out that without dependable information it is difficult or even impossible to make a reasonable decision. Air Pollution Agencies have numerous sources of information -private research organizations, colleges and universities, government laboratories, individual consultants, etc. With all this assistance available, there is a tendency to build an accurate, dependable body of knowledge that can be used as an information source by decision makers.

3. This activity dramatizes a decision-making process in which chance plays a significant part. A great deal is known about weather, what causes various weather patterns, how and why the patterns change. Work is even being done in weather control, especially in connection with promoting or augmenting rainfall and in dissipating storms that are in the process of being formed. Most of this work is done by meteorologists and weather scientists, but there is always someone to represent the citizens who will be affected by the experiments or control operations.

4. Tell the class that at certain times of the year the east coast of the United States is subject to hurricanes that are capable of enormous destruction. The forces unleashed by a hurricane are many times more than those of a nuclear bomb ! The causes of hurricanes are under constant study. At times, research aircraft have been intentionally flown into the "eye" (center) of a hurricane to obtain data. A great deal of data is being obtained from satellite photographs.

5 The earth and its atmosphere are constantly undergoing complex heat-exchange processes. Because the earth's axis is tilted, the amount of solar radiation falling on various regions changes with the seasons. This has an effect on the earth s surface that we see as climate and weather. Hurricanes are re-

lated to this seasonal change. At certain times of the year on the east coast, people begin to follow weather forecasts very closely, sometimes apprehensively.

6. A decision that must be faced when a hurricane is forecast is whether or not to secure a town. Tell the students that in parts of Florida the residents will often lock up their houses and move inland and stay at motels that are inshore. This requires the expenditure of personal expenses. But to the people entrusted with the decision as to whether or not a town must be secured, there are community expenditures involved.

7. Ask the students to speculate on what steps might be taken to secure a town that is expected to be hit by a hurricane. Point out that certain steps must be taken with the town's gas, electric, water, and waste disposal systems. Hospital patients may have to be moved. Schools may have to be closed. Airlines, trains, and public transportation systems are affected. All of these measures cost money, and the decision-maker must be as objective as possible in his judgment.

8. Hand out a Student Activity 10 to each student. Tell the class that each student is in the role of a community official who must decide whether or not the towns on the map should be secured. Go over the student materials, and lead the students through the example on p. 2 (Disaster Control Officer Guide).

9. Distribute a pair of dice to each student, and tell the class to begin. Tell the students to read the Hurricane Game Scoring Directions on p. 5 carefully, and to choose towns on the map. Point out that the results of each "play" must be recorded on the Hurricane Warning Chart (p. 6).

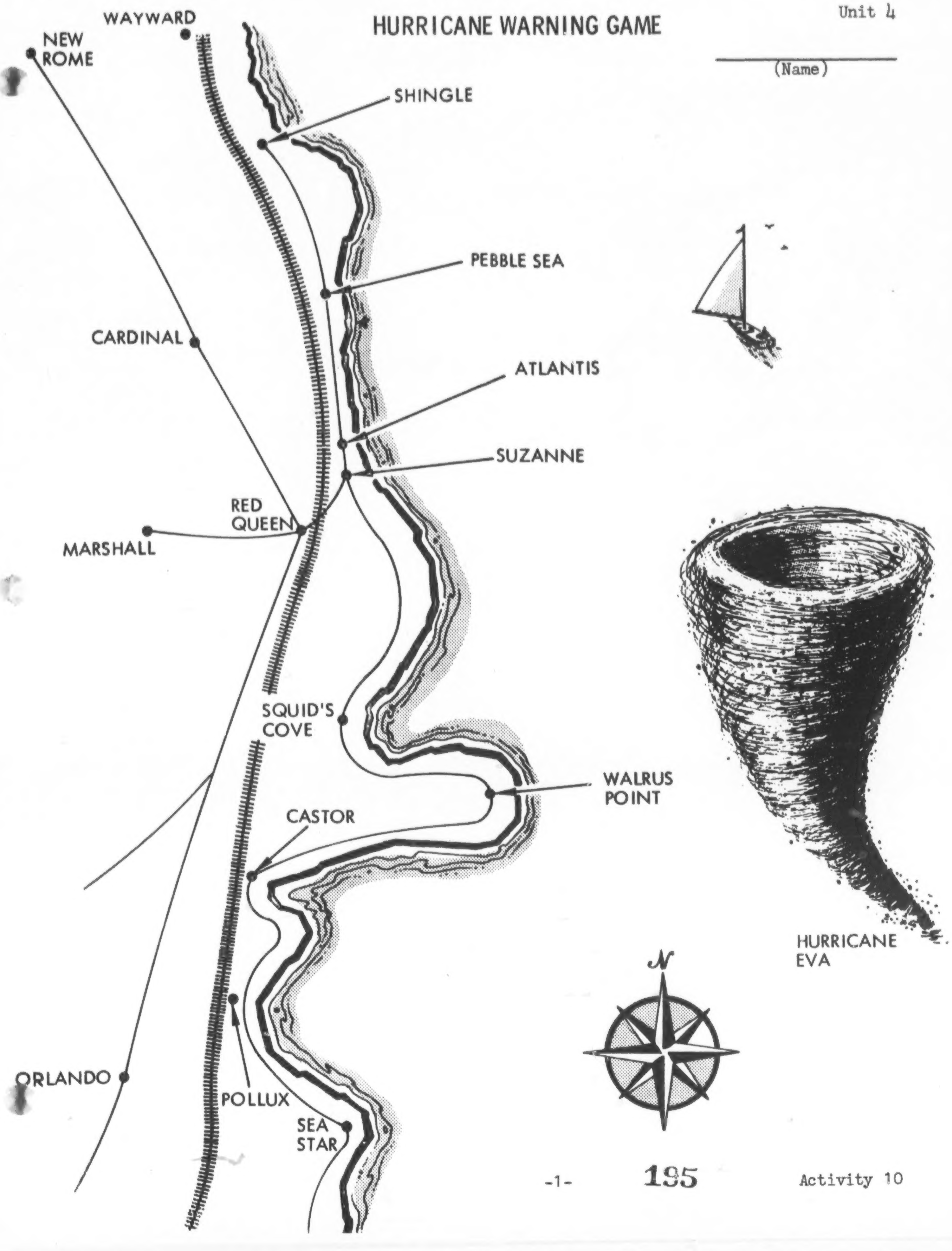
10. Toward the end of the classroom period, tell the students to stop making their determinations. Poll the students on their results, and ask students to report how "lucky" they have been. Ask the students whether they believe this game has dealt with probability (chance) realistically.

11. Collect student materials and check them for SOLO accomplishment.

Unit 4

____
(Name)

HURRICANE WARNING GAME



DISASTER CONTROL OFFICER
Guide

- When the Coast Guard issues a Hurricane Warning, the decision must be made on issuing instructions to secure the town.

- Securing a town costs money. These costs are shown on the Hurricane Preparation Chart. Write the cost for your town here.

- There are varying probabilities that the hurricane will hit your town. This is also on your Hurricane Preparation Chart. Write the probability of the storm hitting your town here.

- If the hurricane really does hit your town, it will do a lot of damage. This possible damage is shown on the Hurricane Preparation Chart. Write the possible damage here.

- Compute the probable savings by multiplying the % of Probability by the Possible Damage.

X =

Probability Possible Damage Probable Savings

- Compare the probable savings with the cost of securing the town.

Cost of Securing Town Probable Savings

- Make your decision based on the comparison of these figures:

< = less than
> = more than

- If < = Secure Town!

Cost of securing town Probable savings

- If > = Do Not Secure Town.

Cost of securing town Probable savings

HURRICANE PREPARATION CHART

Town	% of Probability	Cost of Securing	Possible Damage
Shingle	6	$ 200	$ 1,400
Pebble Sea	14	$ 800	$ 5,600
Cardinal	8	$ 3,000	$ 2,100
Atlantis	19	$ 400	$ 2,800
Suzanne	19	$ 500	$ 3,500
Marshall	3	$ 600	$ 4,200
Red Queen	25	$ 1,000	$ 7,000
Squid's Cove	31	$ 3,000	$ 21,000
Walrus Point	42	$ 1,000	$ 7,000
Castor	17	$ 800	$ 5,600
Pollux	14	$ 1,000	$ 7,000
Orlando	6	$ 4,000	$ 28,000
Sea Star	3	$ 2,000	$ 14,000

PROBABILITY

Town	Percent	Number
Shingle	6	11
Pebble Sea	14	8
Cardinal	8	4
Atlantis	19	4 or 5
Suzanne	19	4 or 5
Marshall	3	12
Red Queen	25	5 or 6
Squid's Cove	31	7 or 8
Walrus Point	42	7,8 or 9
Castor	17	7
Pollux	14	8
Orlando	6	11
Sea Star	3	12

HURRICANE GAME

SCORING DIRECTIONS

- If you Secured Town!
  - And the storm hit your town.

☐	-	☐	=	☐
Possible Damage		Cost of Securing Town		Savings

  - And the storm missed your town.

☐	=	☐
Cost of Securing Town		Loss

- If you did not Secure Town:
  - And the storm hit your town.

☐	=	☐
Possible Damage		Loss

  - And the storm did not hit your town.

☐	=	☐
Cost of Securing Town		Savings

- Enter your Loss or Savings in the proper column of the Hurricane Warning Chart.

- Copy the rest of the information about your town that you need from the Hurricane Preparation Chart to the Hurricane Warning Chart.

____
(Name)

HURRICANE WARNING CHART

Your Town	Cost of Securing Town	Expected Damage	Loss	Savings